Report of the COQUITLAM WATERSHED PIPELINE INQUIRY

Douglas L. MacKay, P.Eng.
Inquiry Commissioner
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Front Cover Photo: Coquitlam Lake and watershed – looking north and showing road along east side of Coquitlam Lake from point north of dam at pipeline routing km 7.7.

Province of British Columbia
Douglas L. MacKay, P.Eng.
COMMISSIONER

Inquiry into Pipeline Routes
In and Around Coquitlam
Watershed

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31 July 1989.

TO HIS HONOUR THE LIEUTENANT-GOVERNOR IN COUNCIL

MAY IT PLEASE YOUR HONOUR,

Under Your Honour's Order in council 759, approved and ordered May 18, 1989, the undersigned was appointed a Commissioner to fulfill the terms of reference contained in the Order and to inquire into and report on a number of issues relating to the proposed routing, construction and operation of the Vancouver Island Natural Gas Pipeline through the Coquitlam Watershed and alternatives thereto.

I have complied with your Order and have the honour to submit herewith my report.

Respectfully,

D. L. MacKay

Douglas L. MacKay, P.Eng.
Commissioner.

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Written and oral submissions were received from a wide range of individuals, organizations and municipalities. The Inquiry is grateful for the information, comments and recommendations contained in their submissions. A full listing of Inquiry participants is given in Appendix B-2. Thanks are due to Dr. John Blatherwick, Medical Officer of Health, who testified at the Inquiry's hearings on water quality, to Mr. Gavin Couper of The Canadian Gas Association and Mr. Jim Colgan of the B.C. Government Gas Inspectorate, who gave evidence on pipeline safety.

To involve and inform the wider public on the issues, evidence and progress of an Inquiry of this kind could not be achieved without the cooperation of the media. Particular thanks are due to Rogers Cable network which aided the Inquiry through advertising and broadcasting the Phase I hearings.

The Inquiry has been assisted throughout its work by its counsel, Mr. A.D.P. MacAdams, of MacAdams Law Firm. The principal technical advisor was Mr. Robert S. Sharman of Sharman Pipeline Consultants Ltd. Mr. Sharman was assisted and advised by Mr. Olav O. Naas. Mr. K.G. Farquharson, P.Eng. provided environmental and other advice to the Inquiry and to Mr. Sharman.

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Finally, the Commission wishes to acknowledge the dedicated and untiring support of the Inquiry Secretary, Mr. Irwin Henderson, without whose knowledge and help the Inquiry could not have completed its work nor produced its report in the short period of ten weeks.

Recommendations

Introduction

The Inquiry was established to review all the technical matters relating to the routing of the pipeline, the availability of alternatives, and the identification and management of water quality and environmental impacts. The report sets out in detail the Inquiry's methods and findings in these matters.

The Inquiry was also mandated to seek out and receive the views of the public, whose concerns and apprehensions over the security of the water supply had been largely responsible for establishment of the Inquiry.

Submissions were received from a wide range of groups and associations, municipalities in the pipeline service area, and individuals. The submissions included petitions which were forwarded by the Municipality of Port Moody and MLAs Mark Rose, John Cashore and Anne Edwards. Other submissions contained technical information such as that prepared by Mr. Frank Bauman P.Eng. The Vancouver Island municipalities of Nanaimo, Alberni, and Campbell River made submissions as did Vancouver, Port Moody, Coquitlam, Anmore, Burnaby, Surrey, Squamish and Powell River. A number of letters contained questions and observations about water supplies, pipelines, perceived risks and other matters.

Through these submissions a number of themes are noteworthy. The first of these is concern over water quality and the integrity of the watershed. The Coquitlam School District wrote to express "deep concern about environmental damage that could result from construction of a gas pipeline through the Coquitlam watershed area" as did the Northeast Coquitlam Ratepayers Association, which advised the Inquiry at the opening day of the hearings that "it is still the belief of our organization that there are alternate routes for this pipeline, and we would like to go on public record as saying that the quality of our water is our priority. We do not want any project going into this watershed now or in the future." The District of Surrey advised of its concern "about the impact to the major water supply for Surrey. Safe, potable water is a fundamental need for all people and must not be compromised or exposed to unnecessary risk."

The second theme was the balance to be struck between acceptance of risk and forgoing the benefits of providing natural gas to the Vancouver Island service area. Ms. Elizabeth Keller and Mr. Brian Lupton wrote saying: "Water is essential to life; natural gas is not. Is it reasonable to put water quality at risk, even minimal risk, for the sake of an optional service?" By contrast, the Inquiry heard from Port Alberni, Campbell River, Powell River, Nanaimo, and the Powell River and Alberni-Clayoquot Regional Districts, which pointed out the benefits the natural gas project would bring to the economy and environment.

A third topic was pipeline safety and concern over potential pipeline leaks, fire hazards and contamination. While some submittors expressed apprehensions, Mayor Turner of Squamish stressed how he welcomed the pipeline, which will be routed through the Squamish municipal watershed. He described how the concerns of the municipality had been addressed by the municipality and PCEC, and he outlined the mitigation methods being discussed with the pipeline company.

A final theme is that routing the Vancouver Island natural gas pipeline through the

Coquitlam watershed would set a precedent for the incursion of other uses in watershed areas. Mr. Stanley McKinnon expressed his concern that the proposal for routing a highway to Squamish and Whistler through the Capilano watershed "will not go away" and that a highway's impacts on the watershed would be "horrendous." The Squamish and Howe Sound Chamber of Commerce, on the other hand, endorsed a route for the pipeline which would go through the Capilano watershed and sees a highway through that watershed as probable in future. While routing different facilities through another watershed is clearly beyond the Inquiry's terms of reference, the Commissioner notes this general concern.

Statement of Principle

All of these concerns have been weighed and considered in light of the factual information documented throughout the Inquiry. In the Commissioner's view, the evidence is clear that implementation of the recommendations from the Inquiry will resolve any water quality problems, will aid the expeditious construction of the gas pipeline project, and will be of benefit to the Water District. Concerns about the integrity of the watershed and the precedent that may be established by allowing the pipeline to pass through the watershed are not as easily dealt with.

The Inquiry and its recommendations should be considered in the context of the following statement of principle, which in the Commissioner's view, is of utmost importance.

The Water District was given control of the Watershed lands for the purpose of production of an abundant supply of clean reliable water. This is the priority.

It is critical that this priority be recognized in considering any activities in the watershed. If a project or activity is to be undertaken, its effects, both short and long term, must be determined and judged in the context of the overriding priority for water production.

If the greater public interest requires the use of watershed lands for other purposes, then all of the costs of maintaining water quality need to be set out and charged directly to that other purpose. In addition, in justifying any other use, it must always be possible, through water treatment or other means, to maintain the capacity to produce the quantity and quality of water that now exists. It must also be recognized that there are uses that will degrade the water in such a way that no amount of treatment will be able to return it to the condition which now exists. These uses, in the Commissioner's view, cannot be justified.

At the same time, the "closed watershed" should be recognized as a means of ensuring water quality and quantity and not as an end in itself. Other activities which are in the public interest, which do not impact the primary function of water supply, which are placed under the Water District's control, and which will provide benefit to the Water District overall should be allowed.

For these other activities, a workable agreement and careful joint planning of construction and operations are necessary to give assurance that the Water District's interests in water quality are fully protected while at the same time ensuring that the Water District in exercising its authority will not do so capriciously.

In this Inquiry evidence was submitted about turbidity and about turbidity standards. There are those who suggest that an activity in the Watersheds is acceptable if it doesn't cause a standard to be exceeded. In the Commissioner's view, for water supply, "polluting to a standard" is not acceptable

practice. Every effort must be made to preserve and where possible enhance water quality.

The guidelines for Canadian Drinking Water Quality are clear in this matter.

The Water District Watershed Management Program of timber harvesting is also directed towards water quality. The evidence submitted is that the GVWD considers cleanest water to be its mandate, and sees a direct relationship between a healthy, vigorous managed forest and high water quality.

It was for the reasons of control that GVWD was granted the watershed. The lease and its amendment recognize the primacy of water quality. It is important that the Water District remain in control of all activities in the watershed. This should apply not only to the Greater Vancouver Water District watersheds, but to all watersheds which supply potable water to significant numbers of consumers.

This Inquiry has recognized the priority of water production from the watershed lands. In its work it has carefully investigated and considered all aspects of the proposed pipeline, not only in the context of immediate impacts and water quality, but also on the need to preserve and protect the lands for the long-term production of quality water for the Greater Vancouver area.

Recommendations

I. Pipeline Route

The evidence is clear that land use, environmental and cost considerations support the route through the Coquitlam Watershed. The evidence is also clear that the risk to water quality from construction of the pipeline through the watershed can be acceptably reduced to a level lower than the levels of risk inherent in normal watershed management. The Commissioner is satisfied that potential negative water quality impacts from turbidity and other causes can be successfully avoided by proper planning, by imposition of these recommended terms and conditions, and by implementation of recommended construction practices and time tables. The recommended measures are not costly and on balance will bring long term benefit to the GVWD in terms of system security, watershed management and financial return.

The Inquiry also considered the operation of the pipeline and found that the risk of accident is negligible and poses no danger to water quality or to the reliability of supply.

Recommendation 1

That subject to adoption and implementation of Recommendations 2 through 13, the Vancouver Island Natural Gas Pipeline be allowed through the Coquitlam Watershed.

II. Water Quality Protection

There is no evidence that water quality will in any way be affected by a natural gas pipeline once installed with the site properly cleaned up and restored. The evidence is that turbidity at the water intake is more likely to be affected by heavy rainfall during construction of the first five kilometres of pipeline north of the dam. That is, between about km 7 and km 12.5. This is due to the nature of the soils and the proximity to the water intake in this area. The soils have been described in evidence as glacial, fluvial, outwash sands and gravels with bedrock, bouldery colluvium and till. These materials

have sufficient fine particles to cause turbidity in the lake and at the intake if the soils are disturbed during periods of rainfall.

Evidence is that the geology along Coquitlam Lake north of km 12.5 is predominantly rock. This, coupled with the length of time it would take particles in the water to travel the 5 or more kilometres to the intake tower, makes the possibility of turbidity arising from this area remote. The Commissioner is satisfied that work in this section could only affect turbidity in the water system if it were done in a careless manner during periods of heavy continuous rain and if the lake were allowed to overflow at the dam.

There is evidence that there are areas of soil above the lake similar to those in the vicinity of the dam and that these also are capable of creating turbidity events. The Commissioner is also satisfied for the same reasons as above that no turbidity impacts will arise from these areas if careful work is done taking proper regard for rainfall and water level.

Measures to control turbidity have been identified in the evidence. These measures involve the proper planning and timing of construction, appropriate construction practices and standards, and good and experienced supervision, inspection and control.

From the foregoing it is evident that work north of km 12.5, in the rock area along the lake and onward to the watershed divide, should be done during the dryer seasons of the year. This work should be done with the lake drawn down to prevent spill in the event of unusual rainfall. It is also evident that to avoid the possibility of turbidity from work in the 5 km section immediately north of the dam, work in this area should be done with the Coquitlam system out of service. Recommendations are made to fulfill these requirements.

Construction of a pipeline through the Coquitlam Watershed will cost the Water District a significant amount of money. There will be costs associated with health testing of workers, provision of sanitary facilities, and inspections to make certain that agreed conditions are adhered to. There will be costs associated with rescheduling of forestry operations to allow pipeline construction full use of the watershed road, and there will be costs associated with removing Coquitlam from service while part of the work is done. The Water District should be reimbursed for all direct costs occasioned by pipeline construction. All of the requirements can be met through adoption of the following recommendations about terms and conditions, construction practices and time table.

Terms and Conditions

Water Quality Protection and Construction Plan

A well thought-out and documented plan is needed to describe in detail how construction is to be carried out and how water quality is to be protected. This plan must be developed by people knowledgeable in practical construction methods and in water quality protection measures. It must be agreed to by PCEC, GVWD and contractors before any work is undertaken in the watershed.

Recommendation 2

That a Water Quality Protection and Construction Plan be prepared jointly by GVWD and PCEC, with the Plan to be in place by October 31, 1989, and with the plan to become part of the contract documentation for work in the watershed and to be agreed to, in writing, by all contractors before any work begins in the watershed.

Construction of Access to the North Boundary of the Watershed

The workforce in the watershed should be kept as small as possible and as much work as can be should be done under direct supervision of the Water District.

Recommendation 3

That as part of the Water Quality Protection and Construction Plan, the GVWD construct to its usual standards using its usual methods and at the cost of PCEC the road and pipeline right-of-way from the end of the existing watershed road to the north boundary of the watershed prior to construction of the pipeline.

The Vancouver Heights Pumping Station

Water system security is a consideration in determining to shut down the Coquitlam source to accommodate pipeline construction. Security can be increased by modest work at Vancouver Heights pumping station.

Recommendation 4

That in order to enhance security of the water system during the time Coquitlam is out of service for construction of the pipeline, the GVWD undertake, and have completed by May 31, 1990 the refurbishing of Vancouver Heights Pumping Station. This work is estimated by GVWD at $125,000 to be done at the cost of PCEC.

Reimbursement of Direct Costs

The Water District will be put to significant costs by reason of construction of the pipeline through the watershed. These costs will relate to such things as monitoring and inspection, health testing of workers, increased watershed security requirements, rescheduling watershed management operations, lost revenue from forestry and changes in water system operation. The Water District needs to be reimbursed for these direct costs.

Recommendation 5

That the Water District be reimbursed by PCEC for all direct costs attributable to construction and operation of the pipeline through the watershed.

Tenure

PCEC needs secure tenure in the watershed for its pipeline. However, the watershed will continue producing high quality water long after the pipeline's useful life is over. The Water District needs assurance that PCEC is given rights only for transmission of natural gas and only for so long as natural gas is transmitted through the pipeline.

The Water District has built the watershed road at its cost. It is of material benefit to PCEC. Compensation is due the GVWD. An agreement is needed to provide for these matters also.

Recommendation 6

That tenure of PCEC for its 12" natural gas pipeline through the watershed lands be by way of an agreement negotiated by PCEC and with GVWD, terms of the agreement to include:

(a) Term — for so long as the pipeline is used for continuous transmission of natural gas.

(b) Product — pipeline to be used only for transmission of natural gas.

(c) Compensation — to be paid in respect of:

(i) use of the road for construction of the pipeline, with the amount of compensation to be based on the surface area of the trench excavated for the pipeline as a percentage of the surface area of the road and road ditch multiplied by the capital cost of the road converted to 1989 dollars;

(ii) use of the road surface for operation and maintenance of the pipeline with a formula for determining the amount of this annual payment is to be negotiated by PCEC and GVWD.

Security After Construction

The pipeline right-of-way will open up a new access corridor to both the south and north boundaries of the watershed. Trespassing will increase and will be difficult to control. These access points need to be closed off to maintain integrity of the watershed's security system.

Recommendation 7

That upon completion of construction through the watershed PCEC close off access by constructing secure fencing at the watershed boundaries and replanting buffer zones along the right-of-way satisfactory to the Water District with ongoing maintenance to be carried out by the Water District at the expense of PCEC.

III. Construction Practices and Timetables

The timing and pace of construction is important, not only in terms of water quality protection, but also in terms of the overall schedule for the Vancouver Island Natural Gas Pipeline. PCEC has suggested the pipeline through the watershed could be built in the fall and winter of 1989. The Commissioner is of the view that this may be difficult to achieve because of the time needed to reach an Agreement and to finalize the Water Quality Protection and Construction Plan for the watershed part of the project. In addition, the project should be built in the driest weather consistent with complete protection of water quality. For these reasons building the pipeline in the winter is not recommended.

All construction activities in the watershed must comply with the Water District's standards and requirements for water quality protection. In this regard in the Commissioner's view a conventional intensive high-speed pipeline project is inappropriate for the watershed. Rather, a smaller controlled operation is required.

Recommendation 8

That the road extension and right-of-way to the watershed's northern boundary be constructed by the Water District at the cost of PCEC in the early fall of 1989 and late spring and early summer of 1990.

Recommendation 9

That the pipeline from about km 12.5 to the northern watershed boundary be constructed in the period August 1 to October 31, 1990, with preconstruction of perennial stream crossings as may be agreed between PCEC and GVWD in the Water Quality Protection and Construction Plan.

Recommendation 10

That the pipeline from the dam to km 12.5 be constructed as early in the fall of 1990 as the removal of the Coquitlam system from service can be effected.

Recommendation 11

That personnel in the watershed for pipeline construction, inspection and supervision be limited to not more than 60 workers at any given time.

Recommendation 12

That all personnel entering the watershed be subject to Water District regulation in regards to health testing, escort and conduct.

The Commissioner is satisfied that implementation of recommendations 8 through 12 will result in a practical, cost-effective construction program that will fully protect water quality.

In the details of preparing the Water Quality Protection and Construction Plan, PCEC and GVWD may agree on other schedules and arrangements that will be as or more effective. Such schedules and arrangements, if agreed, should be implemented.

In this regard, the Water District has identified improvements and additions to the water system which could be built in time to increase capacity into the Coquitlam service area and thus allow earlier shut-off of the Coquitlam reservoir.

PCEC and GVWD should examine such options. If savings in pipeline construction costs can be achieved by work on the water system or the Water District can do other things to make construction more economical, then appropriate financial arrangements can and should be negotiated between PCEC and GVWD. Both organizations provide services to their customers and are supported by public money. The most economical use should be made of these funds.

Dispute Resolution

The Water District should rightfully control all activities in the watershed. For this project the right to control pipeline construction activities in the watershed in

relation to water quality is given by PCEC in the documents filed as evidence, and is given by the conditions in the draft Energy Project Certificate. PCEC's final submission to the Inquiry stated that "PCEC took no objection to such conditions in the hearing before the B.C. Utilities Commission and takes no objection to those conditions now".

Both PCEC's and GVWD's final submissions to the Inquiry suggested a dispute resolution mechanism, but expressed confidence that PCEC and GVWD can work together to prepare and successfully implement the necessary Water Quality Protection and Construction Plan to see the completion of the pipeline. The Commissioner has no evidence to the contrary. Nevertheless, "the best laid schemes o' mice an' men gang aft agley"; a dispute resolution mechanism is necessary.

Recommendation 13

That PCEC and GVWD prepare terms of reference and provide for the appointment of one mutually-agreed final arbitrator of the terms of the Water Quality Protection and Construction Plan under the Commercial Arbitration Act and that the Plan provide for provision of a final arbitrator of disputes during construction which are not resolved by the parties within 36 hours or as otherwise agreed in the Plan.

IV. Other Issues

The Inquiry received submissions on subjects not related directly to routing the pipeline through the Coquitlam watershed and alternatives to the watershed. Two of these, location of the compressor station, and concerns of the Greater Victoria Water District are viewed by the Commissioner as deserving of comment.

Compressor Station

A compressor station must be located near the connection to the 20-inch B.C. Gas Inc. existing pipeline on the Westwood Plateau.

Submissions were received about compressor station siting from Coquitlam municipality, the local authority having zoning jurisdiction, and from Westbild Enterprises Ltd., which now owns much of the land in the area, as well as the Village of Anmore and GVRD Parks Department.

While specific recommendations are not made about location and design of the compressor station, the concerns raised about it are underlined and PCEC is urged to be sensitive to these concerns and local requirements in locating and designing the station.

Greater Victoria Water District

Concerns of the Greater Victoria Water District are not related to water quality during construction but rather to the long-term effect of increased access to its lands. The proposed pipeline routing is through the Water District lands but not through land now used for production of drinking water.

The concerns are similar to those of GVWD in regard to access and deserve the same remedy. Although not within the terms of reference of this Inquiry a recommendation is made.

Recommendation 14

That PCEC close off access along its right-of-way at the boundaries of the Greater Victoria Water District lands by secure fencing and replanting of a suitable buffer zone and that maintenance of the fencing land buffer zone be done at the cost of PCEC.

CHAPTER 1

Introduction

Gas to Vancouver Island

In the 1950s, transmission pipelines first began to bring natural gas from British Columbia's Peace River region to markets in the populous Interior and southern parts of the Province and to the export markets of the United States. Since then, there have been many proposals to transmit natural gas to Vancouver Island, a major population and industrial centre. Various proposals throughout the 1960s and 1970s failed to be realized.

The federal government's National Energy Program of 1980 provided for a subsidy to extend gas service to Vancouver Island. This matched the subsidies given to extend gas service from central Canada eastwards across Quebec and towards the Maritime provinces. In 1982, to ensure that the most cost-effective proposal was selected, the British Columbia government undertook a review of private-sector proposals and then called for competitive applications for project certification.

Following hearings by the B.C. Utilities Commission, the southern marine crossing proposed by B.C. Hydro was selected from amongst the competitive applications. However, the required federal and provincial financial assistance did not materialize to allow this project to proceed.

Renewed commitment by the federal government led, in October 1987, to a new call for proposals by the B.C. government. Of the five proposals submitted, that of Pacific Coast Energy Corporation (PCEC) was chosen as bringing the most economical gas service to the largest industrial and residential markets on Vancouver Island and the Sunshine Coast. PCEC, the chosen company, is a partnership of Westcoast Energy and Alberta Energy Corporation.

In September 1988, the Provincial and Federal Governments signed a Statement of Principles on the provision of funding to the project. On the strength of this joint understanding, PCEC submitted an application for an Energy Project Certificate to the Hon. Jack Davis, B.C.'s Energy Minister, in November 1988. The company's application was reviewed by involved government agencies and the B.C. Utilities Commission was then directed to review the application in public hearings. These took place from January to March 1989. The Utilities Commission's Interim Report to the provincial government was submitted on 14 March 1989 and its Final Report on 6 April 1989. These reports were made public on April 14, 1989 at which time it became known that the Utilities Commission had recommended that the pipeline be routed through the Coquitlam Watershed, subject to PCEC's satisfactory implementation of specific environmental conditions.

Involvement of Greater Vancouver Water District (GVWD)

Although Westcoast Transmission had discussed a proposed natural gas pipeline route through the Coquitlam Watershed with GVWD officials as early as 1984, there had been no substantial discussion leading to identification and resolution of problems before PCEC made its Energy Project Certificate application to the Province.

In January 1989, the GVWD, apprehensive about the potential effects of pipeline construction on water quality and on the control of its watersheds, sought and was granted intervenor status at the Utilities Commission's public hearings.

At its meeting on January 25, 1989, the GVWD Board of Administration, made up of elected representatives from fourteen Lower Mainland member municipalities, passed the following resolution:

> "That the Board support a Notice of Intervention at the public hearing before the British Columbia Utilities Commission into the Vancouver Island natural gas pipeline proposal and direct staff to advise the applicant, Pacific Coast Energy Corporation, that based on the very short notice and limited information provided on the watershed environmental impact assessment, the District is unable to support the pipeline proposal at this time. Also that the Board request Pacific Coast Energy Corporation to submit their plans for the proposed pipeline to the Board for its review."

On March 9, 1989 and again on March 22, 1989 the Board's Water and Waste Management Committee considered this matter further, and received reports from staff who had reviewed a route assessment report prepared by PCEC in response to the GVWD concerns.

The staff advised:

> "as an overall comment while measures are included to avoid chemical contamination resulting from explosives and a third party environmental inspector reporting to the GVRD is provided for, major sensitive technical aspects of the water quality issue are inadequately addressed with respect to tolerable levels of turbidity, an effective monitoring program or feasible mitigative measures. In discussions with Westcoast they have expressed their intent to accommodate and address our concerns but basic technical issues such as these have not been satisfactorily dealt with."

Following consideration, the Water and Waste Management Committee recommended that PCEC be advised that "the projected impact on water quality and the monitoring program and mitigative measures for addressing this impact are unacceptable."

With receipt of this information, the GVWD at its meeting on March 22 passed the following resolution:

> "That the Pacific Coast Energy Corporation Route Assessment Report on the Coquitlam Watershed be received and the Company be advised that the projected impact on water quality and the monitoring program and mitigative measures for addressing this impact are unacceptable to the Board, and
>
> That the Board advise the B.C. Utilities Commission and the Federal and Provincial Governments of the Board's decision to oppose construction of the pipeline through the Coquitlam Watershed."

A month later, at its meeting on April 26, the GVWD considered material contained in the B.C. Utilities Commission Report which had been publicly released on April 14, 1989 by the provincial government.

The GVWD then passed the following resolution:

> "That on the basis of evidence contained in the B.C. Utilities Commission report,

there is insufficient information to conclude that the risk to the water supply is acceptable and manageable and the Board reaffirms its position to oppose the pipeline construction through the Coquitlam Watershed."

This latter resolution was reaffirmed at the May 2 meeting of the GVWD by the following:

"That the Administration Board reaffirm its position, taken at its meeting of April 26, 1989, that on the basis of evidence contained in the British Columbia Utilities Commission report, there is insufficient information to conclude that the risk to the water supply is acceptable and manageable and the Administration Board opposes the proposed construction of a natural gas pipeline through the Coquitlam Watershed."

The provincial Energy Minister, the Hon. Jack Davis, wrote to the GVWD on April 26 asking that it participate with other agencies in a committee to oversee the routing of the pipeline. This was also reviewed by the Board at its May meeting, which resolved:

"That the Administration Board respond to the letter of April 26, 1989 from Hon. Jack Davis stating that it is not prepared to participate in a committee dealing exclusively with a pipeline route through the Coquitlam Watershed, but would be prepared to look at alternative routes through the Greater Vancouver Regional District if all information were made available."

"That staff be asked to investigate and report back on the appropriateness of proceeding with the federal Environmental Assessment Review Panel process."

News stories reporting the GVWD Board resolutions and other expressions of concern made the proposed routing through the Coquitlam Watershed a matter of public interest. Various questions were raised in the provincial Legislature about the proposed watershed route and two petitions were presented to the Legislature on 2 May 1989.

Appointment of the Inquiry

In order to examine, document and report all the factual information on the proposed routing and the availability of alternatives, the Provincial Government, by Order in council 759 of May 18, 1989 appointed the Commissioner, set out terms of reference, provided a reporting date of July 31, 1989 and empowered the Commissioner to hire staff, conduct the Inquiry, and hold public hearings. The Commissioner was granted the powers of a Judge of the Supreme Court as provided in the Inquiry Act. His terms of reference and oath of office are set out in Appendix A of this report. Notice of the Inquiry's first public meeting was published in the B.C. Gazette on 15 June 1989, in conformity with the requirements of the Inquiry Act. With the announcement of the appointment of the Commissioner, both the GVWD and PCEC issued news releases welcoming the establishment of the Inquiry and offering their organizations' fullest cooperation.

Inquiry Organization and Staffing

The Commission began its work on May 20, 1989 by retaining Mr. Robert Sharman as an expert advisor. Mr. Sharman is well known in the pipeline industry as a man of broad experience familiar with all aspects of pipelining including costing, construction practices, underwater pipelines and project management. Arrangements

were made to have Mr. Irwin Henderson seconded from the provincial Ministry of Energy, Mines and Petroleum Resources to contribute his knowledge and experience of public inquires and to act as Secretary to the Inquiry. He immediately made arrangements for organization, administration, office accommodation and staffing. The Attorney General was requested, in accordance with the Order in council, to appoint counsel and on May 22, 1989 Mr. Douglas MacAdams, an experienced litigator, was appointed Counsel to the Inquiry.

As the Inquiry's work of reviewing pipeline routing issues proceeded, Mr. Sharman arranged for additional expert advisors and assistants. These included: Mr. Keith Hunt, an experienced pipeline engineering technician, who was seconded from B.C. Gas Inc.; Mr. Olav Naas, an internationally-recognized expert in earth-moving, rock-work and cost estimating; Mr. Ken Farquharson, P.Eng., M.I.C.E., a widely-respected, expert environmentalist who has advised governments, public bodies and private companies on environmental and land use matters; Dillingham Construction and McIlheny Engineering, both well-established B.C. contracting and engineering companies who provided underwater depth soundings of Indian Arm and advice on underwater pipeline costs and installation; Singleton Associated Engineering Ltd. of Calgary provided construction advice and cost estimates of some of the routing alternatives studied by the Inquiry; and Mr. Milos Stepanek, M.Sc., P.Eng. of Geo-Engineering (M.S.T.)Ltd. also of Calgary, provided his geotechnical expertise to the complex issue of pipeline routing along the east side of Indian Arm.

The assembly and analysis of this data was complex, and Price Waterhouse was retained to develop a uniform computerized cost-estimation model from its preliminary stages. The results of this work were made available to both GVWD and PCEC as the estimates were developed. All the final results were placed on the public record at the Inquiry's hearings.

Information Requests and Technical Meetings

With the establishment of the Inquiry, detailed Information Requests were sent to the B.C. Utilities Commission, Pacific Coast Energy Corporation and the Greater Vancouver Water District. On May 24, 1989 meetings were held with each of these to lay the foundations for the Inquiry's investigations. Full cooperation was extended at these meetings, legal counsel were identified, and the process of consultation and information exchange was begun.

Throughout the Inquiry, the technical experts and staff of the Inquiry, GVWD and PCEC continued to meet to share information on the questions of pipeline routing and cost estimates. Consultant reports were freely exchanged and, while full agreement did not result, the process of information-exchange continued. It is thanks to this process that the Inquiry was able to move rapidly to assemble data, pinpoint areas of contention and proceed to this report.

Public Review Procedures

All of the Inquiry's procedures were designed to develop and place on the public record all of the information and evidence upon which the conclusions and recommendations contained in this report are based. These procedures included seeking input from all members of the public, organizations, or corporate entities having an interest in the

watershed routing issue and ensuring that the technical evidence developed by GVWD, PCEC and the Inquiry's own advisors was submitted to the public through the hearings.

In order to ensure the widest public awareness of the proceedings, the Inquiry's Notice of Public Hearing was advertised in the major daily newspapers and 28 local papers circulating in the Greater Vancouver/ Lower Mainland area. The Commissioner also issued public statements explaining the terms of reference and publicizing the hearings. He also made himself available to the media for interviews to explain the issues the Inquiry was charged with. The hearings were held in Burnaby, selected as the epicentre of the Greater Vancouver region, and full transcripts were lodged in the Burnaby Public Library to ensure availability of the Inquiry's written record to interested members of the public.

At each stage of the hearings, Public Advisory Notes were prepared and distributed. These provided, in digest form, overviews of the issues under consideration, maps of the routes being examined, guides to the procedures being followed, and an agenda of the witnesses being heard each hearing day. Media Advisory Notices were also issued, to provide this information to the news media in a timely way.

After the hearing notice was published, 46 parties registered their interest in making presentations to the Inquiry. These included 12 municipalities, 2 Indian Bands, 2 Ratepayers' Associations, 2 private companies, and 29 organizations and individuals. Arrangements were made for those wishing to submit in writing without appearing in person to have their information placed on the public record. In order to allow the fullest expression of public opinion, the Commissioner announced that submissions would be accepted throughout the life of the Inquiry from those wishing to contribute them.

Appendices B and C provide complete listings of the submittors, witnesses, written submissions, Commissioner's statements, and public information documents of the Inquiry's procedures.

Of note were the non-adversarial procedures adopted by the Inquiry. In the Commissioner's view, only a co-operative and consultative process could allow the establishment and thorough review of a factual information base necessary to fulfill the terms of reference. In addition, GVWD had resolved that it would examine alternatives if "all information were made available." Thus, technical information was shared amongst GVWD, PCEC and the Inquiry's technical staff. Meetings were held to review the facts and opinions of staff and consultants. Field tours involved all these parties and the computer-generated cost estimates and the program itself were made available freely.

This non-adversarial approach was maintained in conducting the public hearings. The hearings were phased so that public submissions were received and entered into the record, and any questions were put to submitters by Inquiry's counsel and the Commissioner.

The technical phase of the hearings involved the taking of evidence on oath from staff and consultants of GVWD, PCEC and the Inquiry's independent experts. Counsel for the Inquiry was assisted throughout by other counsel in the preparation of witnesses. All questions at the hearing were chanelled through the Inquiry's counsel and all witnesses were called by the Inquiry. At the conclusion of the hearings counsel for GVWD and PCEC each gave a submission from their client's perspective covering the terms of reference, the evidence before the

Inquiry and their view of appropriate conclusions and recommendations. The Commission is pleased that both GVWD and PCEC viewed the process as fair, effective and efficient.

The reason for adopting this non-adversarial approach was not from any particular desire to spread good will, but because the Commisioner recognized that a very large data-base existed within the GVWD and PCEC, and that while they had taken opposing views of the pipeline routing issue, the facts needed to be compiled, reviewed and used to develop logical conclusions. The consultative approach also dictated the Inquiry's choice of experts who were, in each case, well-respected, widely-experienced and of a stature whose opinions might bring the greatest possible measure of agreement.

CHAPTER 2

Selection of the Watershed Route

The pipeline route through the Coquitlam Watershed was selected in PCEC's Energy Project Certificate Application of November 1989 as part of the overall route for the pipeline from Coquitlam to Squamish, Texada Island and Vancouver Island. Figure 1 is a map of the project on Vancouver Island, the Sunshine Coast and the Lower Mainland.

The source of natural gas for the project is an existing 20-inch diameter natural gas pipeline owned by B.C. Gas Inc. This line has the primary purpose of supplying gas to B.C. Hydro's Burrard thermal electricity generating plant. However, this pipeline has the necessary capacity to supply gas for the Vancouver Island project. Thus the starting point for the pipeline project is identified as the Westwood Gate Station in Coquitlam near the Port Moody/Coquitlam boundary.

The overall scope and route of the pipeline was described in evidence by Mr. Kavanaugh, Vice-President of Engineering and Construction for Westcoast Energy, responsible for the design and construction of the Vancouver Island Pipeline project:

> "MR. KAVANAUGH: Mr. Chairman, the scope of the Vancouver Island Pipeline project is to supply natural gas to Vancouver Island itself, and to as many of the communities along the route as is possible. As presently envisaged, the pipeline project would begin in Coquitlam and head northward towards Squamish.
>
> After reaching Squamish, it would turn south and west and bring gas to the Sechelt Peninsula, after which it would cross by marine crossing to Texada Island, where it would traverse the length of that island and bifurcate at the north end to an eastward connection to Powell River, and a westward connection to Vancouver Island at a site called Little River, which is north of Comox.
>
> The system would traverse virtually the entire length of Vancouver Island [sic], with laterals to Campbell River and Port Alberni. It will service seven major pulp mills along its route, as well as numerous communities. At the present time, the system main line length is some 500-odd kilometres. It will be serviced by initially one compressor station located in the Coquitlam area, with future stations added as the load requires.
>
> The system is estimated to cost some $250 million and has an optimal capacity of some 150 million cubic feet of natural gas a day, although that capacity can be expanded to some 200 million cubic feet of natural gas without too many diseconomies.
>
> It is presently scheduled that the pipeline would be completed by the fall of 1990. We expect at the moment, on the current schedule, to release contractors September 1 of this year. The project has been competitively bid by construction contractors. Those bids have been received and analyzed. However, we have not made, as yet, an award.
>
> In terms of the marine sections of the project, they will be installed at the moment by the bottom pull technique.

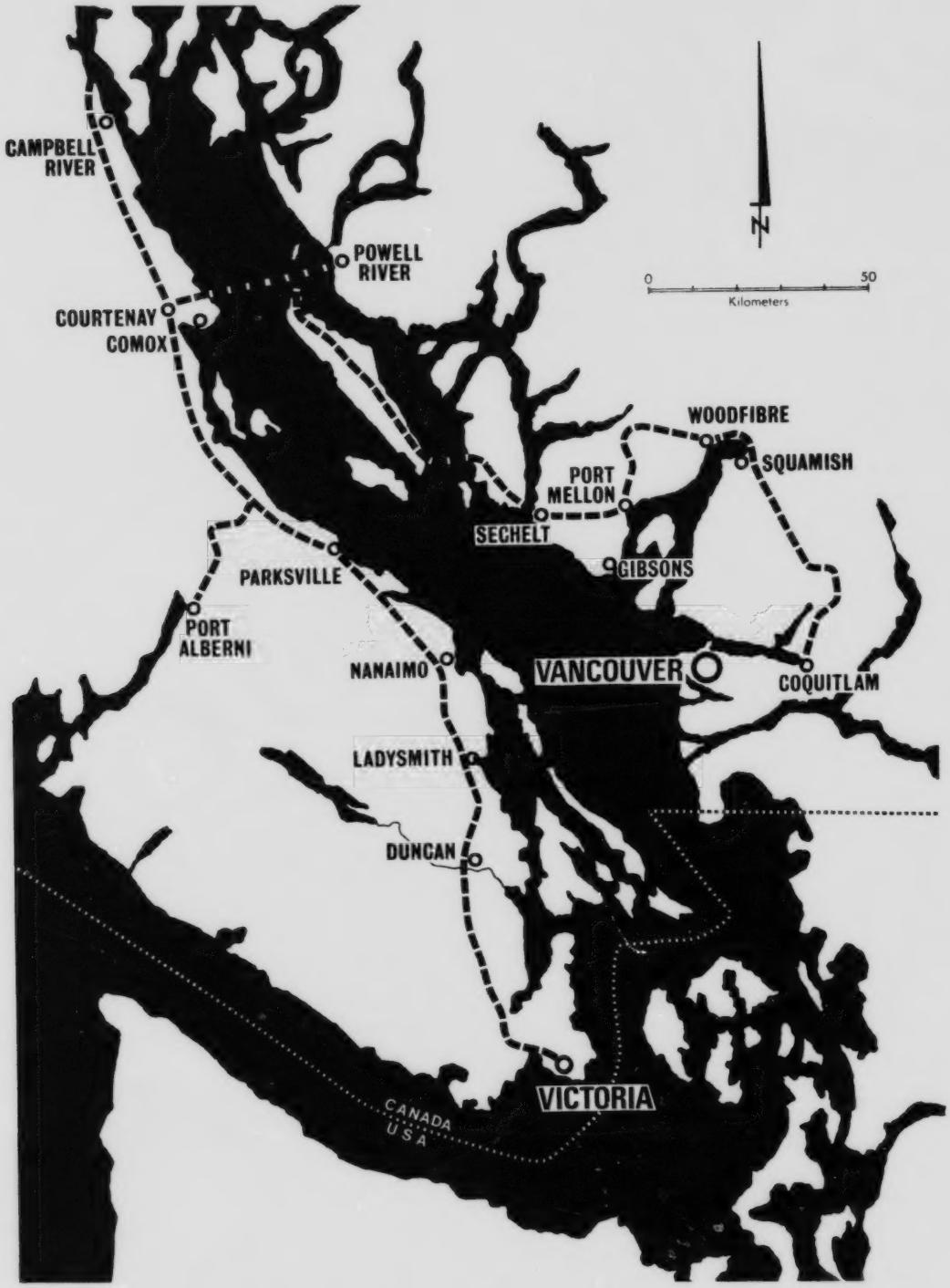


Figure 1 — Vancouver Island Pipeline project

That technique has been widely used throughout the world for such installations.

That work will be under a sub-contract to Westcoast, a sub-contract held by Intec Engineering of Houston, Texas, an internationally recognized marine consulting and construction firm. I think, Mr. MacAdams, that about summarizes the project."

[Transcript, pp. 432-434]

PCEC Routing Criteria

In establishing the routing for the pipeline, PCEC applied certain route selection criteria. These criteria were set out in PCEC's Energy Project Certificate Application and were considered by the Inquiry.

PCEC's criteria fall into two parts. The first, entitled "Route Selection and Project Design", describes the procedures normally followed, including liaison with regulatory authorities, private land-owners, occupants and users of Crown land. Reference is made to environmental and socio-economic impact assessments and also to design and routing criteria. The second part, "Design and Capacity of Facilities — Engineering Detail Pipeline — Routing," states that the routing of the proposed pipeline was determined having a regard to a list of eight individual items. These eight items were described in the hearings as follows:

"MR. MacADAMS: And if I could just invite you to go through those criteria, making any comments you think would be useful for the Commission to have to develop an understanding of what criteria were applied to this pipeline.

MR. KAVANAUGH: Well, beginning with the first item, Mr. Chairman, the first item suggests that we have routed this pipeline based upon Westcoast's general pipeline experience, and based upon our experience and study, the expected environmental impact that the project would have upon the environment.

And the second criteria, we make note that we have given regard to the location of facilities owned by the British Columbia Hydro and Power Authority. And that is particularly important as far as the Island section of the project itself is concerned, because on the Island we propose to route the pipeline along the existing 138 kv power line for most of the distance. That power line happens to run in a favorable north/south direction.

I should observe, Mr. Chairman, that the voltage of that power line is not high enough to give us any concerns regarding induced voltage effects, which effects, for those that are interested, can be reviewed in the recommended practice attached to CSA Code Z-184.

Point number three makes reference to existing hydroelectric right-of-ways, and there it's included because we have studied the location of other electric power lines and whether or not they would be suitable in a common corridor concept for location of the pipeline.

Primarily, the power lines we have in mind in that instance are those such as the 550 kv power line found in the Coquitlam area.

We've also, in point number four, given regard to the total mileage of the pipeline, and in our experience it's best if one can, all other things considered, arrive with the least possible mileage for a pipeline.

The least possible mileage will give you, all things being equal, the least possible

cost, the least social disruption, the least environmental disruption.

As noted in point number five, we have given regard to the location of high-density population areas. We have two concerns for that particular point.

The first is to be in proximity to those high population loads for the attachment of that load to the pipeline, since this project needs all of the load that it can attach in order to be economic.

However, we would like to be, from a security point of view, as far away from those high-density population areas as we possibly can, and you will note that, Mr. Commissioner, in our routing of the pipeline along Vancouver Island, that we have chosen to set ourselves back from those communities at a reasonable distance.

Our routing is not the same as that suggested by other proponents who, over time, have considered a pipeline on Vancouver Island. You will recall, I think it was last Friday, the testimony by Mr. Gavin Couper [of the Canadian Gas Association] about the number one concern for pipeline incidents, and that is the effects of third-party activities on pipeline systems.

As noted in point number six, Mr. Chairman, we considered the ease of access for pipeline construction and operation. That is what we find when we propose to construct a pipeline through, for example, the Coquitlam Watershed.

We also find it in other areas along the routing, and we have chosen wherever possible to route the pipeline where ease of access exists, so that from, as we suggest, a construction and operations perspective we do the least disturbance, both during construction and operation.

As noted in point number seven, in a general sense, we have looked at the ease of overall pipeline construction, and for example, many parts of the pipeline routing are through areas of very difficult terrain.

However, one cannot construct pipelines throughout British Columbia without at some time or another encountering difficult terrain. One of the problems you have with construction in British Columbia, of course, is the presence of mountainous terrain, which means that one inevitably encounters rock, both grade rock and ditch rock. You also encounter major streams, and the crossing of some of those streams can prove interesting.

So, in routing this pipeline we have given regard to the terrain, or as you may more aptly describe it, geotechnical matters, and tried wherever we can to minimize the construction costs. Again, there's a spin-off for minimizing construction cost, and that is a minimizing of the effect of the project on the environment.

As noted in point number eight, we have given consideration to the proximity of various cities, which goes back to the matter of load, but in this particular instance, as well we're concerned with constructing the pipeline in close proximity to seven major pulp mills. Those pulp mills are expected to consume some 9 BCF [billion cubic feet] a year of natural gas, out of an initial volume of some 12 or 13 BCF.

[Transcript, pp. 438-442]

Mr. Kavanaugh described the process of applying these criteria and testified in regards to alternatives to the Coquitlam Watershed:

"MR. MacADAMS: Now, how far along the process of route selection and the application of criteria did routes along Indian Arm go? Now, I use that

deliberately vague description of routes along Indian Arm because there have been a multiplicity of routes over time. But how far along in the internal process did the Indian Arm possibilities go before being set aside, prior to going to the BCUC hearings?

MR. KAVANAUGH: The only basic routing that we considered up Indian Arm was the east side. We never really contemplated the west side because of the dual water crossings required.

But, in any event, none of the — the Indian Arm consideration really went much beyond the development of preliminary capital cost estimates, and based upon what those estimates told us and in our experience, having regard to environmental and socio-economic matters without having to do in and of themselves definitive studies in those disciplines, we were able to put aside any Indian Arm consideration because we knew that — or believed that, in our opinion at least, the watershed routing was favorable, or more favorable than routing up the Arm.

MR. MacADAMS: All right, and if I understand you correctly, in considering the Indian Arm possibilities, there were no memoranda created, there were no geotechnical studies done; your environmental and land-use people were not brought in. It was at the very preliminary stages that Indian Arm was set aside, am I correct on that?

MR. KAVANAUGH: In the very preliminary stages you're correct. . . .

MR. MacADAMS: Prior to making application to the British Columbia Utilities Commission, Mr. Kavanaugh.

MR. KAVANAUGH: That is correct."

[Transcript, pp 456-457]

Earlier Route Evaluations

Mr. Kavanaugh noted that in the 1970's a Westcoast Transmission routing study for an earlier project had selected the east side of Indian Arm as a pipeline route. However, this was before the construction of the road through the Coquitlam Watershed. Mr. Kavanaugh's statement showed the importance of existing access in determining the preferred routing:

"COMMISSIONER MacKAY: And looking at the map, the [Indian Arm east side] route would seem to be the shortest route?

MR. KAVANAUGH: Yes.

COMMISSIONER MacKAY: And then Item 6 is the ease of access for pipeline construction and operation. This, I think, is an opinion on your part, and I would ask you for it. If there wasn't a road through Coquitlam, which there wasn't in the early 1970's, would this pipeline still be routed through the Coquitlam Watershed?

MR. KAVANAUGH: I think that would be very difficult to do, to route it through the Coquitlam Watershed, because of the volume of material that would have to be removed to create the necessary right-of-way. I'm assuming, Mr. MacKay, that the Watershed is in operation during this time.

COMMISSIONER MacKAY: Yes.

MR. KAVANAUGH: So what you'd be looking at is trying to build a long linear right-of-way in a short period of time where one doesn't exist. I think that would be very, very difficult.

COMMISSIONER MacKAY: So it's safe to assume that the existence of that road is a fairly valuable commodity?

MR. KAVANAUGH: The existence of the road is important in terms of having this pipeline constructed."

[Transcript, pp. 612-614]

In October 1984, Westcoast Transmission Company Ltd. contacted the GVWD about a preliminary proposal to route a natural gas pipeline through the Coquitlam Watershed to supply a possible industrial site in the Squamish area. The Water District replied stating that its approval would be subject to eight specific conditions. These included: scheduling; location of the pipeline in relation to the dam, existing and planned roads; recovery of costs; the need for the Water District to retain control over all environmental and water quality concerns; and the need for GVWD to have the ability to stop the project whenever water quality was at risk.

Four years later, in April 1988, and after the routing criteria noted above had been applied to the Vancouver Island natural gas pipeline, the GVWD was again contacted. In response the GVWD advised that not only would the previous conditions apply, but that:

"Some discussion to support the Watershed routing is needed, since at first glance a shorter route via the B.C. Hydro right-of-way adjacent to Indian Arm, would appear to offer opportunities for this project. Subject to our acceptance of your justification for the suggested watershed alignment, the general conditions set out in our letter of October 30, 1984, would remain in effect and form the basis of our conditional approval."

Unfortunately PCEC did not respond to this request for justification of the watershed route. Rather, the company proceeded without further contact with the GVWD and filed its Energy Project Certificate Application seven months later in November 1988. The Application was referred to the B.C. Utilities Commission for public hearings by the provincial government in December 1988.

A chronology of major events in the proposed routing of the pipeline through the watershed has been compiled from the evidence and the public record.

Chronology of Events — Watershed Pipeline Routing

October 1, 1984	Letter from Westcoast Transmission Co. Ltd. to GVWD requesting consideration of preliminary proposal for route through Coquitlam Watershed.
October 30, 1984	Letter from GVWD to Westcoast Transmission Co. Ltd. listing eight conditions to which approval would be subject.
March 21, 1988	Letter from Westcoast Transmission Co. Ltd. to GVWD requesting confirmation of October 30, 1984 conditions.
April 27, 1988	Letter GVWD to Westcoast Transmission Co. Ltd. requesting justification for Coquitlam Watershed route prior to confirming conditions.
November 1988	PCEC Application to B.C. Minister of Energy and Petroleum for an Energy Project Certificate for Vancouver Island pipeline.

November 17, 1988	GVWD phone call to PCEC regarding project activity.
November 23, 1988	GVWD – PCEC meeting: report requested on cost of alternative routes.
November 1988	PCEC application referred to B.C. Utilities Commission.
December 21, 1988	BCUC issued procedural instructions to PCEC.
December 23, 1988	PCEC advised GVWD that report requested November 23 was being prepared.
December 27, 1988	BCUC procedural instructions and timetable for hearings advertised.
January 10, 1989	PCEC route maps and cost estimates to GVWD.
January 12, 1989	GVWD advised PCEC cost estimates unsatisfactory because too generalized.
January 17, 1989	Revised cost estimates sent to GVWD.
January 18, 1989	GVWD advised by BCUC that late intervenor submission would be accepted.
January 24, 1989	BCUC hearings commence.
January 25, 1989	GVWD Board resolution supports intervention at hearings.
March 6, 1989	Environmental report given to GVWD on water quality issues.
March 9 & March 22	GVWD – Water and Waste Committee considered staff reports and concluded "projected impact on water quality and the monitoring programme and mitigative measures are unacceptable".
March 22, 1989	Board resolution confirms Water and Waste Committee and Board decides to oppose construction of the pipeline through the Watershed.
April 14, 1989	BCUC Reports on PCEC Vancouver Island Pipeline Application made public.
April 26, 1989	GVWD Board reaffirms its decision to oppose the pipeline route through the Coquitlam Watershed.
April 26, 1989	Hon. Jack Davis, Minister of Energy, Mines and Petroleum Resources, meets with GVWD Board.
May 2, 1989	GVWD Board reaffirms its decision to oppose the pipeline route through the Coquitlam Watershed.
May 18, 1989	Order in Council establishes the Inquiry.

Conclusion

The controversy surrounding this matter may well have been avoided and the Inquiry itself been unnecessary if PCEC had responded promptly to the GVWD's request and if it had identified, in an objective way, the alternatives to the watershed route and had worked together with the GVWD to develop methods to overcome legitimate concerns.

CHAPTER 3

GVWD and the Coquitlam Watershed

Greater Vancouver has a cheap and plentiful supply of drinking water available from its watersheds. Few other large metropolitan areas in the world are so fortunate as to have such a system. The water system has maintained its ability to supply ample and economical quantities of water, keeping pace with the Lower Mainland's greatly expanding population and industrial demands. At the same time, high water quality standards have been maintained in the face of ever-increasing environmental pressures on the region's earth, air and water resources.

Formation

The Greater Vancouver Water District was formed over 60 years ago by Act of the Provincial Legislature. The Province granted the District 999-year leases for the watersheds of the Capilano and Seymour Rivers. Later, the watershed of the Coquitlam River was added. These leases included all unoccupied Crown land within the Capilano, Seymour and Coquitlam drainages and land which later reverted to the Crown.

Over the years, the GVWD has acquired land from other sources and now has full control over all the lands of the Capilano, Seymour and Coquitlam watersheds from which domestic water is produced. These watersheds have been developed by dams, reservoirs, pipelines, tunnels and pumping stations to form the water supply system for the entire Greater Vancouver metropolitan area with a population of over 1.3 million. Figure 2 shows the extent of the three watersheds, reservoirs and main pipelines.

The people of the Greater Vancouver area have benefitted and continue to benefit greatly from those who recognized the need to acquire and control the watersheds. As Mr. Morse, GVWD's Chief Engineer and Manager of Water and Construction stated to the public hearings:

> "MR. MORSE: When the Water District was incorporated in 1924, some 65 years ago, the foresight in the original terms ensured that all the activities in the Greater Vancouver Water District Act would fall under the control of the Water District personnel. And the founders of this district, going back to Dr. Cleveland, who the Cleveland Dam is named after, were very farsighted in their judgment in that regard. They wanted to ensure that all the environmental aspects were addressed and, as such, they probably were the original environmentalists in the Greater Vancouver area long before the word became the kind of household buzz word that it is today.
>
> Over the years this operating philosophy has not changed, and it's reflected in our closed watershed policy that I referred to earlier and eliminates all the opportunities for contamination from the urban area.
>
> We're speaking of contamination that can come from vehicular activity, from hikers, from domestic animals and things of that like that can bring viruses and other organisms as well as chemical contamination into the watershed through trespass or whatever. And those activities are controlled."
>
> [Transcript, pp. 742-743]

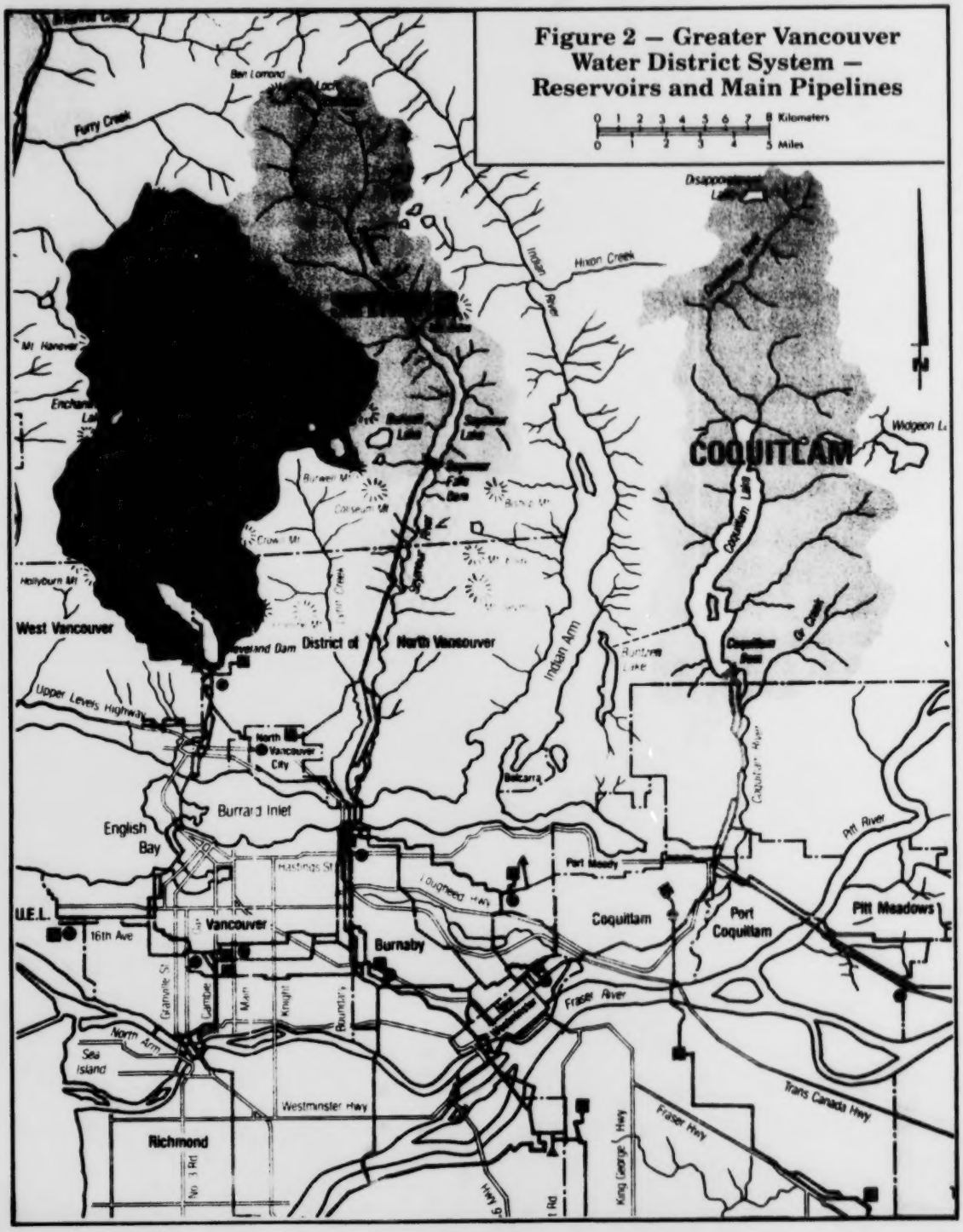


Figure 2 — Greater Vancouver Water District System — Reservoirs and Main Pipelines
0 1 2 3 4 5 6 7 8 Kilometers
0 1 2 3 4 5 Miles
COQUITLAM
West Vancouver
District of North Vancouver
Burrard Inlet
English Bay
Vancouver
Burnaby
Coquitlam
Port Coquitlam
Port Moody
Pitt Meadows
Richmond
Sea Island
North Arm
Fraser River
Indian Arm
Indian River
Hixon Creek
Coquitlam Lake
Widgeon L.
Upper Levels Highway
Lougheed Hwy
Westminster Hwy
Trans Canada Hwy
Fraser Hwy
16th Ave
Hastings St
Granville St
Cambie
Main
Knight
Boundary
No. 3 Rd
No. 1 Rd
King George Hwy
Port Mann Bridge
Pitt River
Coquitlam River
Ben Lomond
Furry Creek
Mt Hanover
Hollyburn Mt
Seymour Lake
Buntzen Lake

Development of Coquitlam Watershed Within GVWD System

The Coquitlam Watershed has a history of supplying drinking water which predates its place in the GVWD. First, it was a source for the Coquitlam Waterworks Company, incorporated in 1886; then for the City of New Westminster, which acquired the Coquitlam Waterworks Company in 1889; and finally for the Greater Vancouver Water District, which assumed the water supply facilities of the City of New Westminster when it joined the Water District in 1930. In 1942, all of the land forming the Coquitlam Watershed was included in the GVWD's 999-year lease.

Coquitlam is the largest of the GVWD's watersheds being some 75 square miles in area. It was developed for water storage by a dam constructed in 1903 to create Coquitlam Lake which extends over 3100 acres. The dam is owned and operated by B.C. Hydro and provides water storage for the Buntzen Power Generating Station. A tunnel from Coquitlam Lake to Buntzen Lake, about two miles upstream of the dam, takes water from Coquitlam Lake to Buntzen Lake where it is used for power production at the Buntzen Generating Station.

Just as the Coquitlam Lake is managed for both power generation and water supply, the Capilano Watershed is crossed by a B.C. Hydro right-of-way carrying 500 kv and other transmission lines to serve Vancouver and Vancouver Island. The Seymour Watershed is no longer managed for other purposes but is devoted solely to water production.

The GVWD uses about 10% of the water produced by the Coquitlam Watershed; the remainder is used for generation by B.C. Hydro. Although the Water District has agreements and licenses to use up to 150 million gallons per day on an annual average basis, the usage now averages less than 30% of that amount. As Mr. Morse testified:

> "MR. MORSE: In the summertime draws the monthly average flows will get up to approximately 55 million gallons per day, keeping in mind that is a monthly average flow. We have daily spikes, given a hot dry spell that would occur that could easily drive up to 85: 85 and in some cases up to 100 million gallons per day on an extreme case."
>
> [Transcript, p. 213]

To show where the water from Coquitlam Lake is used, Mr. Morse provided a map and stated:

> "MR. MORSE: . . . the total population that we serve in Greater Vancouver as wholesaler to the member municipalities is about 1.3, 1.35 million people. The Coquitlam source feeds approximately two hundred and fifty thousand of that population.
>
> In terms of the area that it is served, the municipalities that comprise the northeast and southeast sectors are generally those, and we're dealing with Port Moody, Port Coquitlam, Coquitlam, Pitt Meadows, Maple Ridge, approximately half of the District of Surrey and the City of Langley, and that's the area that we serve. And also, I should say, there's two others; portions of New Westminster and east Richmond.
>
> That area is about to undergo a fairly significant transformation with the inclusion of the Township of Langley, which does not reflect on that map, and it is expected probably within the next year to eighteen months we will be delivering significant quantities of water to the Township of Langley. They're about to become a member of the district.

In terms of the area that is served percentage-wise, I would suggest we were probably dealing with 40 per cent. Forty per cent of the Greater Vancouver area is fed from the Coquitlam source, but it is a generally less densely populated area than the areas that are fed from Capilano/ Seymour".

[Transcript, pp. 217-218]

Water Quality in the GVWD System

All three GVWD sources, Coquitlam, Capilano and Seymour, supply excellent quality water. The water is carefully monitored for bacteriological quality, physical quality and chemical quality.

One of the physical quality parameters measured is turbidity, a measure of the "cloudiness" of the water caused by the presence of particles of organic or inorganic material. Turbidity is measured in Nephelometric Turbidity Units (NTU) by a machine called a nephelometer or turbidity meter.

Mr. Robert Jones, a chemist and GVWD Administrator of Water Quality, described the appearance of samples of water at various NTU levels:

"MR. JONES: . . . if the turbidity level is less than 1 NTU. . . the water is crystal clear.

If the turbidity is around the 5 NTU mark, you would . . . not really notice it unless you held it up to the light . . . .

When you get to 10 NTU, you would start to notice it visibly if you ran the water in a glass.
And by the time you got to about 20 [NTU], it would become opaque".

[Transcript, p. 246]

Dr. John Blatherwick, Vancouver's Medical Health Officer and medical advisor to the GVWD, gave evidence on the health concerns posed by the proposal to route the pipeline through the Watershed:

"DR. BLATHERWICK: . . . turbidity, that's the only real risk to health."

MR. MacADAMS: . . . at what levels of NTU and of days or longer periods of time do the concerns of you and your fellow medical health officers begin to come into effect?

DR. BLATHERWICK: We don't like to see it go over five very often . . . And just as a rough guideline, we've said . . . that 10 NTU for periods of three days are what we do not want to see, because that poses the greatest risk.

MR. MacADAMS: But it's fair to say that periods of more than 10 NTUs for more than three days do not, as a certainty, pose a health problem; is that a fair statement?

DR. BLATHERWICK: Yes, it is. We have had those events, as I pointed out from the evidence I previously gave, that in Capilano we have had higher than 10 NTUs. Our bacteriological counts at the tap have been acceptable, and so the risk I am referring to is a theoretical risk and not something that has to happen all the time".

[Transcript, p. 336]

Evidence given to the Inquiry in its public hearings showed that of the three watersheds, Coquitlam has the least history of turbidity events. For 15 of the past 20 years, the 5 NTU standard was not exceeded on any single day. Averaging all test results over the 20 year period of record, the 5 NTU limit was exceeded for less than one day per year or 0.3% of the time. The data also

showed that following the rare turbidity events which did occur, the water in Coquitlam cleared quickly.

The report prepared by the GVWD's water quality consultant, Mr. G. Kirmeyer, entitled "GVWD Water Quality Improvement Plan" contained tabular information on turbidity in the three watersheds. Relevant data are shown in Figures 3 and 4.

In speaking to this, Mr. Jones said:

> "MR. JONES: Coquitlam, looking at the same level of 5 NTUs, it exceeded the 5 NTU guideline approximately 0.3 per cent of the time during that 20 years.

And about the length of time that turbidity levels remain high, before settling to their normal levels:

Figure 3 — Annual Frequency of Peak Turbidities at the Source 1968–1987

Turbidity>5 NTU (days)

	Capilano	Seymour	Coquitlam
1968	2	0	2
1969	0	4	0
1970	0	1	0
1971	0	0	0
1972	11	1	0
1973	36	17	0
1974	12	17	0
1975	8	9	0
1976	10	0	0
1977	1	15	0
1978	1	0	0
1979	15	6	6
1980	8	5	0
1981	79	46	4
1982	8	2	0
1983	46	5	0
1984	73	4	2
1985	0	0	1
1986	7	2	4
1987	4	0	0

Turbidity>10 NTU (days)

	Capilano	Seymour	Coquitlam
1968	0	0	1
1969	0	0	0
1970	0	0	0
1971	0	0	0
1972	1	0	0
1973	15	6	0
1974	2	0	0
1975	2	4	0
1976	1	0	0
1977	0	7	0
1978	0	0	0
1979	0	0	0
1980	2	5	0
1981	22	44	3
1982	0	0	0
1983	46	0	0
1984	18	0	1
1985	0	0	0
1986	1	0	1
1987	0	0	0

"MR. MacADAMS: Turning now to the duration of turbidity levels . . . how long do these excess turbidity levels last in water from each source?

MR. JONES: . . . Capilano, we can have occasions where we will see turbidity levels extend for long periods. . . . you know, it could be up as much as two or three months.

On Seymour, my experience has been that it's been somewhat less than that, but we have seen . . . elevated turbidity levels for a period of a month.

In the case of Coquitlam, there haven't been too many turbidity events. However, the ones that did occur were quite short-lived, and usually returned to their normal levels in a relatively short time."

[Transcript, pp. 250-251]

Also reported by Kirmeyer are the months in which excess turbidity levels have occurred, shown here in Figure 4. In all watersheds, turbidity most frequently occurs in the high rainfall seasons of the year. Based on the past twenty year's records, Coquitlam runs no risk of turbidity from March through September. By contrast, turbidity is most frequent in Capilano, where all months but April, August and September have turbidity events recorded.

The Inquiry sought the reason for the Coquitlam's less frequent turbidity occurrences and their shorter duration. Experts testified to the Inquiry that this was due to the coarser-grained soils predominant in the Coquitlam valley. These larger particles settle out much more rapidly compared to the finer-grained materials in other watersheds.

Figure 4 — Monthly Frequency of Peak Turbidities at the Source 1968–1987

Turbidity>5 NTU (days)

	Capilano	Seymour	Coquitlam
Jan.	76	30	4
Feb.	72	0	5
Mar.	9	0	0
Apr.	0	0	0
May	5	7	0
June	3	9	0
July	1	1	0
Aug.	0	0	0
Sept.	0	0	1
Oct.	18	6	0
Nov.	56	55	4
Dec.	81	26	5

Turbidity>10 NTU (days)

	Capilano	Seymour	Coquitlam
Jan.	27	25	1
Feb.	7	0	1
Mar.	1	0	0
Apr.	0	0	0
May	0	6	0
June	1	0	0
July	0	0	0
Aug.	0	0	0
Sept.	0	0	1
Oct.	1	0	0
Nov.	37	30	3
Dec.	36	5	0

The GVWD has developed strategies to minimize the effects of turbidity events and thus maintain the supply of high quality water to its customers throughout the system. One of these strategies is to interchange sources — that is to use water from one watershed in the service area normally supplied by another. A further part of this strategy is to mix water from different sources so that more turbid water can be diluted to meet the overall 5 NTU water quality guideline.

To accomplish the goal of source interchangeability, the District has continued to make improvements to its physical supply system by installing pipelines, pumping stations and reservoirs. These facilities are primarily needed to meet the system's increasing peak demands, but when at less than peak demand, they give the capability of transferring water from one watershed service area to another.

As part of its source interchange strategy, the GVWD has facilities which permit it to remove the Coquitlam source from service. Since 1975, the Coquitlam reservoir has been taken out of service seven times, ranging from a three-hour trial shutdown, to periods of five to ten days for facilities and water inspection, to longer periods of 4½ to 5½ months for major facilities maintenance. All shutdowns have taken place between early October and mid-May.

The operational procedures to remove the Coquitlam Reservoir from service are detailed and complicated, consisting of 33 separate steps taken throughout the system, ranging from minor valve adjustments to starting a large pumping station to provide water to major parts of the metropolitan area.

The capacity of the overall system to provide water into the Coquitlam service area without the Coquitlam source is approximately 50 million gallons per day. This is sufficient to accommodate normal fall/winter peak flows.

The GVWD's capital plan was received in evidence and contains improvements which would increase the capacity to move water into the Coquitlam service area from the other two reservoirs.

CHAPTER 4

Watershed Management Activities

The GVWD plans and carries out activities in its Seymour, Capilano and Coquitlam watersheds according to a comprehensive Watershed Management Program. Activities include fire protection, drainage control, selective timber harvesting, reforestation, access road building and maintenance. Approximately 23% of the Coquitlam Watershed's 21,113 hectare area allows for normal logging practices, 11% requires site-specific logging plans and 65% is environmentally unsuitable for timber harvesting.

The Aqua Terra Classification System

In order to guide its management planning, the Water District has developed an "Aqua-Terra Classification System" which scientifically defines the watershed reserve and forest management areas according to their biophysical characteristics and capabilities.

In summary, the Aqua-Terra Classification System integrates and interrelates the land and aquatic systems of the watershed. Five Watershed Reserve and Forest Management Units are defined through consideration of the land's slope, gradient, soil properties, water regime and regenerative ability. The five Units range from environmentally fragile areas where no activity is permitted, to the areas where road construction and ground yarding systems present no problems or risks to production of clean water.

Watershed management through selective timber harvesting has as its aim the maintenance of young, vigorous forest cover in the watershed. Research shows that this is beneficial to both water quality (in avoiding organic material and lessening fire hazard) and to water quantity (by making snow-melt less extreme).

In the Coquitlam Watershed, the program of selective timber harvesting began during the mid-1970s to control an infestation of Hemlock Looper in an area immediately upstream and east of the dam. The road building program had begun a few years earlier to improve access throughout the watershed for fire protection and forest management. The forestry provisions of the Watershed Management Program are carried out under the provisions of a 1967 amendment to the 999-year leases. This allows the Water District, while using the watersheds as a source of high quality water, to manage the lands in accordance with an approved Forest Management Plan which includes the selective harvesting of timber. In entering into this multiple-use amendment, the Province and the Water District recognized the priority of water production by the inclusion of the following clause:

> "That the parties hereto recognize that the highest priority in the management of the lands to which this amending Indenture applies must be given to water supply purposes, both in terms of quality and quantity of water, and that the provisions of the forest management plan must be secondary to this objective".

The revenue from the sale of timber pays all the expenses of the Watershed Management Plan, and surplus is placed in a special-

purpose fund which now stands at approximately $7 million.

Timber Harvesting

The watershed leases require that all forestry activities are conducted within the provisions of a Forest Management Plan approved by the Chief Forester of the Province. The Plan provides, amongst other things, for the harvesting of timber on a sustained yield basis. Each cut-block within the Plan is subject in turn to a detailed cutting permit which the Water District obtains by application to the Ministry of Forests for specified work.

Following these planning and permitting procedures, the Allowable Annual Cut within all three watersheds has been set at 200,000 cubic metres of timber. The Water District now has an application before the Ministry of Forests to change its Forest Management Plan and reduce this to 180,000 cubic metres per year. As testified by Mr. Edward Hamaguchi, GVWD Administrator of Watershed Management and a B.C.-registered professional forester and engineer:

> "MR. MacADAMS: I understand the maximum amount of wood that GVWD can harvest in any year is regulated by the Forest Service, is that correct?
>
> MR. HAMAGUCHI: That's correct.
>
> MR. MacADAMS: And that this overall maximum is subject to a reduction in the next few years, is that correct?
>
> MR. HAMAGUCHI: Yes, presently we have an application with the Ministry of Forests whereby we are requesting reduction from the 200,000 down to 180,000, based on removing from the land base areas which we feel could be detrimental to water quality. So, it is down to 180,000, and of that 180,000, land-based harvesting practices is about 120,000, and the remainder is aerial logging.
>
> MR. MacADAMS: Now, by land-based logging practices, you mean going in with equipment on the land and taking the wood out in that way, correct?
>
> MR. HAMAGUCHI: That's correct.
>
> MR. MacADAMS: And that is the method by which you have presently been doing all your logging, is that correct?
>
> MR. HAMAGUCHI: That's high-lead logging, that's correct, plus we have done some aerial logging in the Seymour Watershed.
>
> MR. MacADAMS: Is it your anticipation that aerial logging techniques will be applied in the future to Coquitlam Watershed?
>
> MR. HAMAGUCHI: That's correct.
>
> MR. MacADAMS: In your three watersheds, what is your usual annual cut?
>
> MR. HAMAGUCHI: Approximately 120,000, based on a high-lead logging system.
>
> MR. MacADAMS: And looking over the last two or three years, what has been your annual cut in the Coquitlam Watershed?
>
> MR. HAMAGUCHI: Well, the present cut in Coquitlam is about 80,000.
>
> MR. MacADAMS: And is there anything in your arrangements with the Forestry Service that would prevent you from

taking all of your cut from Coquitlam in a given year, and leaving Seymour and Capilano alone?

MR. HAMAGUCHI: No, except that in our planning we wish to spread out our operation to all three watersheds.

MR. MacADAMS: And the flip-side of that is that it would be possible for you in a given year to squeeze down on the logging within Coquitlam Watershed and reallocate your activities to the Seymour and through the Capilano Watersheds, is that correct?

MR. HAMAGUCHI: That is possible, yes.

MR. MacADAMS: Is there something more that needs to be said on that topic?

MR. HAMAGUCHI: Well, the only thing is that any short-term changes like that requires a fair amount of planning, because we do work on a five year plan, and that's all approved prior by the other agencies. And to go make a sudden change is not quite that easy because the harvesting plan is predicated on having the road system at least, or more or less, within two years ahead of time, so changes are not done in a couple of weeks or anything like that."

[Transcript, pp. 640-643]

Mr. Hamaguchi explained that the plans for 1989 and 1990 are already in place, but with time for proper planning, they could be altered. Changes in the plans are not hampered by regulatory or financial barriers, but by the physical constraints of road construction for timber harvesting in the other watersheds.

In reference to the 1990 harvesting program in the Coquitlam Watershed, Mr. Hamaguchi testified further:

"MR. HAMAGUCHI: The 1990 program would encompass 80 hectares, and we're looking again at one small block down on branch 200 that's referred to, on the east side, opposite more or less the Island, northern tip of the Island, and another block on the west side about halfway up the lake, and then we have three blocks at the northern end of Coquitlam Watershed, past Flyin Creek.

MR. MacADAMS: All right. And so it's intended that the road would be extended beyond Flyin Creek to service the logging in that more northerly portion sometime between now and 1990, correct?

MR. HAMAGUCHI: That is correct.

MR. MacADAMS: And when exactly — in what months of what year are you presently planning to do that road extension work?

MR. HAMAGUCHI: Well, the plans in this area is to extend from Flyin Creek to about there, this year, if we can.

MR. MacADAMS: And there you're indicating a distance that would service some, but not all, of the 1990 logging intended area, am I correct?

MR. HAMAGUCHI: That's correct, because we have some bridge construction involved in that.

MR. MacADAMS: And then the balance of the road to serve the 1990 program, you would intend to build in what month of what year?

MR. HAMAGUCHI: Probably mid — early spring in 1990."

[Transcript, pp. 646-647]

Road Building

As part of the overall Watershed Management Program and to support its fire control, logging and reforestation activities, the Water District has built access roads through each of its watersheds and has a continuing road construction and maintenance program. Roads are built as part of the Forest Management Plan, but are multi-purpose. As Mr. Morse testified:

> "MR. MORSE: I might add here, some of the reasons that the roads are constructed, the harvesting program is only part of the reason; there's a variety of others, and these include access to control the watersheds in terms of disease and the growth; to maintain the watershed, watercourses; to remove any potential debris torrents that could impact on the water quality, and also one of the more important events is to provide good access for forest fire protection."
>
> [Transcript, p. 640]

In the Coquitlam Watershed, the road program began in 1971, when the first parts of the main road were built. The main road has been extended from the dam to near the north boundary of the watershed, and other access roads lead from the main road to various parts of the watershed. There is now a total of 80 km of road in the watershed, with approximately 4 km built in an average year. The 1990 program would see continuation of the main road past Flyin Creek in the northern part of the watershed.

Prevention of Contamination/ Security Through Limited Access

All of the watershed activities are closely controlled by the Water District. Workers are subject to health testing and are given educational programs. A video shown to all workers was praised by Dr. Blatherwick, as an effective means of preserving hygiene.

Dr. Blatherwick stated that these programs, taken together, reduce the concern over water quality from pipeline construction or other causes:

> "COMMISSIONER MacKAY: So could I take it from that that you and your colleagues would be much more concerned if the Watershed Management Program that's in effect and the health testing and the education wasn't there, turbidity would be more of a concern?
>
> DR. BLATHERWICK: Oh, absolutely. I think the fact that we do have a protective watershed, we would have an education program for anybody going in, whether it's the pipeline workers or our own workers, that those things give you the confidence that probably you're not going to run into great problems.
>
> COMMISSIONER MacKAY: And I could take it . . . that if the pipeline crew were in place and the same rigorous program was applied, and the turbidities, for instance, never exceeded 5 NTU, you wouldn't be concerned?
>
> DR. BLATHERWICK: No. In fact, I would suspect that given the publicity that this has had, that the pipeline workers would probably be the most model people we would send in."
>
> [Transcript, p.349]

For all those entering the watershed, stringent regulations are enforced respecting conduct within the watershed and sanitation facilities are provided. The watershed gates are manned 24 hours per day and patrols prevent unauthorized access. Records are kept at the gate of all entries, and escorts are provided for those who need to enter the watershed for any reason, but who may not be properly health-tested.

The number of persons within the watersheds at any given time varies. The maximum number in any one watershed at any given time has been estimated at 60 persons. But, as Mr. Morse testified:

> "MR. MORSE: That's an absolute maximum. I refer to a figure earlier that indicated that we are probably talking in the order of somewhere around 25 or 30, would be an average type of figure. Sixty is the absolute maximum. I think that's reflected in some of the evidence that we submitted." [Transcript, p. 724]

Similarly, the presence of vehicles is closely watched and all vehicles are recorded at the watershed gatehouse. Records show that the number of vehicles in the Coquitlam Watershed is highest during active timber harvesting. During the three-week period June 19 to July 7, 1989 while the Inquiry was pursuing its work, an average of 43 vehicles per weekday was recorded at the gatehouse. This total was made up as follows:

28 pickups, vans and cars

2 crew carriers

1 other (including low-beds, tow trucks, concrete trucks)

12 logging trucks (loads).

CHAPTER 5

Alternative Routes

The GVWD's resolutions of January, March, and April relating to the pipeline project express three concerns: that insufficient information was available on the construction of the pipeline through the watershed; that the availability of other alternatives had not been addressed; and that the potential impact on water quality had not been adequately resolved.

Similar concerns were also reflected in the Inquiry's public hearings. A number of submitters raised the lack of information on these issues as well as expressed a wish to see that all practical alternatives to the watershed were considered before any decision on routing was made.

The Inquiry's terms of reference require it specifically to examine alternatives, investigate water quality, environmental and other potential impacts and to recommend mitigation and terms and conditions to be applied to construction of the pipeline.

The Inquiry has examined in detail the proposed Coquitlam Watershed route along with five possible alternatives. These alternatives represent different ways in which gas to serve the Vancouver Island project might be delivered from the Lower Mainland to Squamish. In the Commissioner's view, they represent the only practical and appropriate routes which might possibly be suggested as alternatives. Other routes suggested would either be variations on these, or impractical, or would not be alternatives to the Coquitlam-to-Squamish routing, but would be alternatives to the total pipeline project and beyond the Inquiry's terms of reference.

To organize the information on the routes, and to reach recommendations and conclusions in an orderly way, the routes were examined in two stages. An overview stage considered all six routes using the broad criteria of length, cost and environmental impacts. On the basis of these criteria, three routes were rejected as being inappropriate for the pipeline corridor. For the remaining three routes, much more detailed study was given, in consultation with GVWD, PCEC and independent experts.

Overview of Possible Routes

Figure 5 maps the six routes examined at an overview scale. Each was given an identifying letter for reference purposes which is shown on the map and which is used throughout the following routing comparison and analysis.

For this overview, preliminary estimates of length and cost were made, with all routes having a common terminus at Squamish, and with the exception of Route D — Kilgard to Squamish, having a common takeoff point on the B.C. Gas Inc. transmission line in Coquitlam.

Route D from Kilgard via Pitt Lake, was the subject of a reconnaissance evaluation which concluded that it was physically possible to construct a pipeline from Kilgard via Pitt Lake which would bypass the Coquitlam Watershed en route to Squamish. Part of

Alternative Routes Examined
Preliminary Reconnaisance Estimates

Route A — Coquitlam Watershed to Squamish: 66.0 km	$38 Million
Route B — Indian Arm East to Squamish: 55.2 km	$52 Million
Route C — Indian Arm West to Squamish: 56.0 km	$49 Million
Route D — Kilgard to Squamish: 130 km + 5 River Crossings	$80 Million
Route E — Coquitlam-Seymour Valley to Squamish: 60.0 km + Crossing of Indian Arm	$42 Million
Route F — Coquitlam-Capilano Valley to Squamish: 60.0 km + Crossing of Indian Arm	$45 Million

this route had been researched as the subject of an Intervention by B.C. Gas Inc. for the Utilities Commission and material was supplied to the Inquiry by B.C. Gas Inc. The route did not pass on to the stage of receiving detailed examination because of its length, high estimated cost and the environmental impacts associated with a large part of the route, notably encroachment into areas of wildlife habitat and penetration into country that is presently not accessed by transportation corridors.

Routes E and F involve pipelines through either the Seymour or Capilano Watersheds. Again, these routes were the subject of a reconnaissance evaluation and were rejected for the following reasons. First, there is not sufficient pipeline capacity in the existing natural gas system on the North Shore of Burrard Inlet to serve the load of the Vancouver Island natural gas pipeline. Thus major expansion in pipeline facilities through heavily populated parts of North Vancouver would be required. Secondly, ground conditions are unfavorable for pipeline construction in the areas north of the Seymour Watershed in the vicinity of Loch Lomond. Finally, as can be seen from the map, the both routes would go through either GVWD's Seymour or Capilano watershed and do nothing to address the issue of ensuring a safe and secure water supply to the Greater Vancouver area. In fact, the soil conditions in both these watersheds result in more frequent and more severe turbidity events for the overall GVWD system as was seen in Chapter 3.

Routes Studied in Detail

Route A, through the Coquitlam Watershed, and Routes B and C, along the east and west sides of Indian Arm, were examined in significant technical detail both by consultation with GVWD and PCEC and by the Inquiry's staff. They are shown on Figure 6. This examination focussed on costs, environmental and land use impacts and reliability criteria. (A variant in Indian Arm presents a further alternative — that of an underwater route up Indian Arm. This

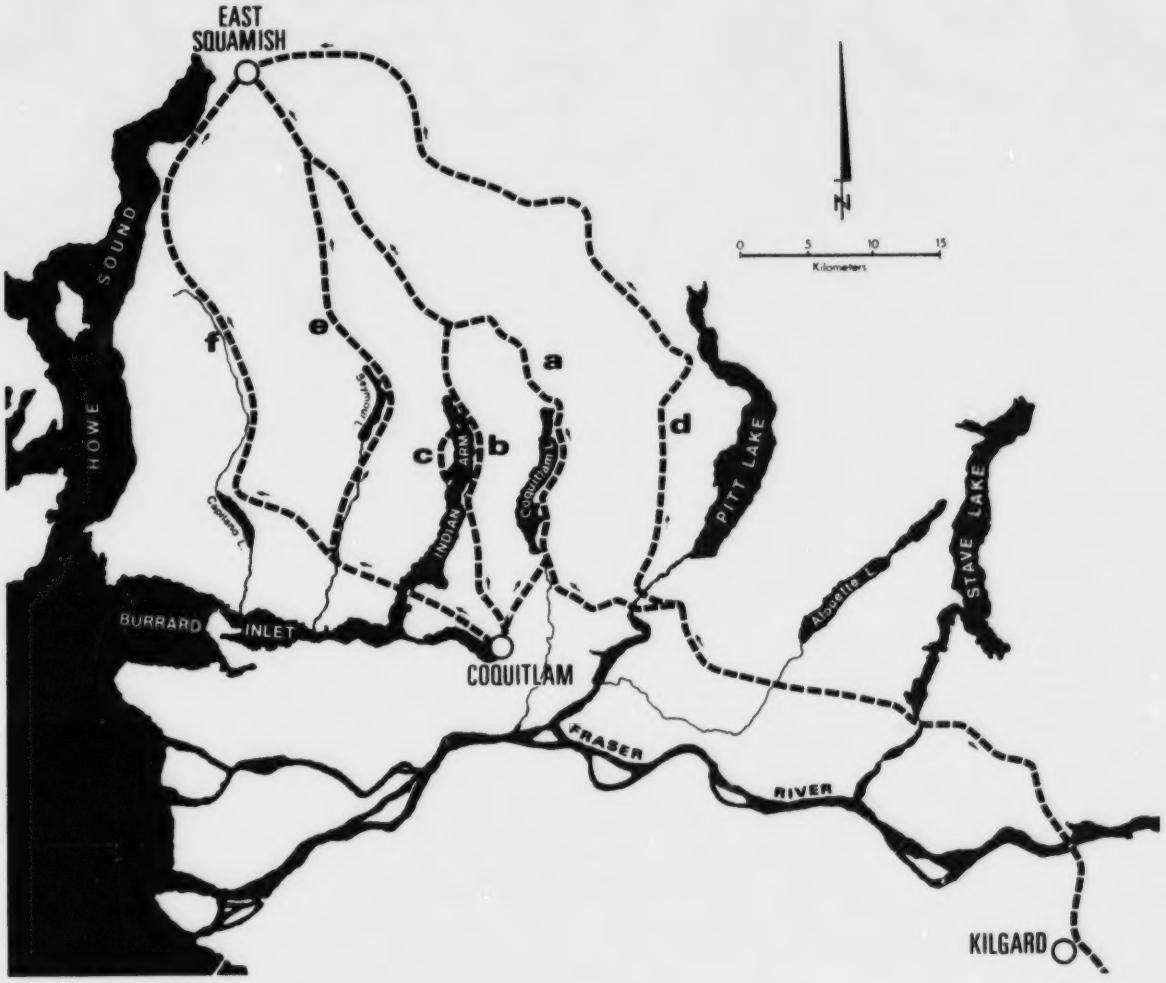


Figure 5 — Alternative Routes Examined

was considered by the Inquiry Advisors but rejected for further evaluation as being uneconomic and impractical because of uncertainties inherent in underwater work coupled with the fact that several major changes in direction would be needed in the underwater route.)

Routes A, B and C all have their origin in Coquitlam at the existing B.C. Gas Inc. 20-inch pipeline. The take-off point is located on the B.C. Gas Inc. pipeline near the Port Moody–Coquitlam border known as the Westwood Gate Station. For the purposes of comparison, the Inquiry's work has used the common point of the Westwood Gate Station as the origin for Routes A, B and C.

Similarly, the three routes have a common northern ending point on the Indian River, as shown on Figure 6.

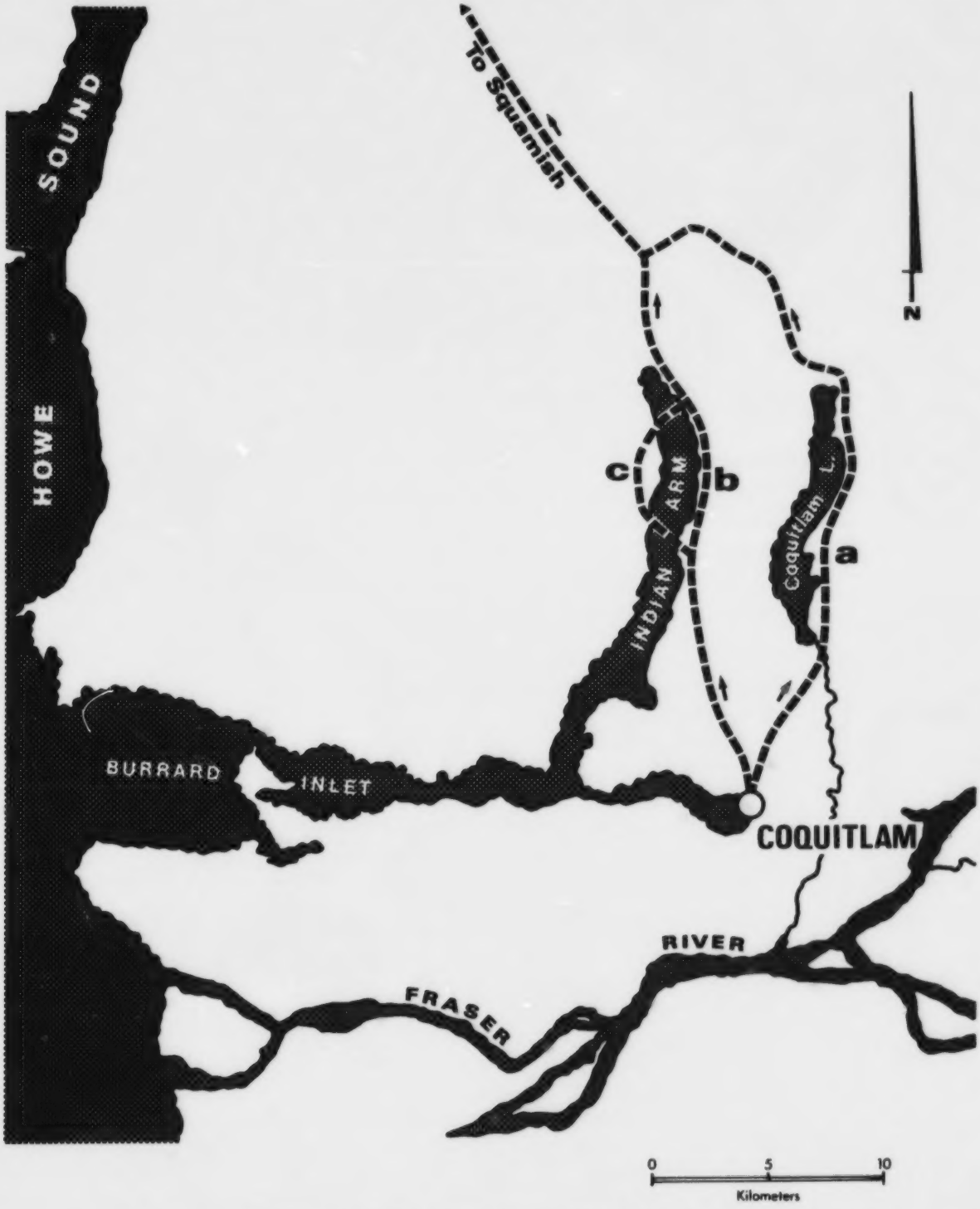


Figure 6 — Route Alternatives: Coquitlam Lake and Indian Arm

The Inquiry's Senior Pipeline Advisor, Robert Sharman, described the route evaluation methodology in the public hearing as follows:

> "MR. SHARMAN: I will now, Mr. Commissioner, outline the steps we have taken, in collaboration with the Water District and Pacific Coast, to fully evaluate these three front runners [Routes A, B, and C], considering distances, terrain, construction practice, costs, and risks, plus the different environmental and resource-use impacts . . .
>
> In order to build up an information base to evaluate the routes, I and the consultants working with me held meetings with PCEC and GVWD and their consultants in an effort to understand the conditions that exist in the three routes, to evaluate the existing information on each of them and, where necessary, to retain experts to fill in the data gaps as they were identified.
>
> . . . For the Watershed route, our work began with helicopter and ground tours of the proposed alignment . . .
>
> The tours and subsequent meetings allowed us to check the report by [PCEC geotechnical experts] Hardy and Associates as to the volume of rock to be removed, the grade and the ditch. We also explored the problems of construction and the precise types of equipment to be used on each phase.
>
> We checked carefully the problems of access in the areas with the narrow and confined right-of-way and in an area of rock bluffs. The potential for any siltation resulting from construction activities was also discussed, along with a method to reduce and avoid this potential.
>
> For the Route B, Indian Arm East: When the Inquiry began its work, the Water District and Pacific Coast were evaluating two different routes along the eastern side of the Indian Arm. Detailed mapping had been prepared by Hardy and Associates. These were discussed and reviewed.
>
> As a result of this consultation, a common route has been agreed, mapped and evaluated . . .
>
> For Route C, the Indian Arm West route: The major feature of route C is its underwater crossing which allows the pipeline to avoid the most difficult area of the west side routing . . .
>
> It was agreed that a best effort estimate would be prepared, using bathymetric data supplied by McElhaney Geosurveys, in order for an experienced local contractor to provide a cost estimate of laying the marine pipeline water crossing. It was recognized that the estimate would not be exact due to the very limited information available and the lack of engineering data . . .
>
> Further information has now been received from Intec Consultants to PCEC on the marine crossings in Georgia Strait, and is now under review."
>
> [Transcript, pp. 419-422]

Route Descriptions

Route A: Coquitlam Watershed

From the Westwood Gate Station, Route A goes through the Westwood Plateau area paralleling the B.C. Hydro power line right-of-way for approximately 5 km. At approximately km 4 the pipeline enters the Coquitlam Watershed, proceeding on the west side of the Coquitlam valley to the Coquitlam dam at approximately km 7. The pipeline is proposed to cross the dam, then

follow the existing watershed road along the east side of Coquitlam Lake to approximately km 21.5, where the pipe crosses the Coquitlam River just above the head of the lake on the watershed road bridge. The pipeline then follows the existing watershed road along the west side of the Coquitlam River to the end of the road at approximately km 29. The pipeline proceeds further along the west side of the Coquitlam River to Flyin Creek and follows Flyin Creek north to the watershed divide near km 30. From km 30 to the Indian River at approximately km 35.6, the pipeline follows the Hixon Creek Valley.

Route B: Indian Arm East

Route B starts from the Westwood Gate Station, crosses part of the Westwood Plateau lands, then goes towards the lower end of Buntzen Lake following the B.C. Hydro power line right-of-way. From km 4 near the lower end of Buntzen Lake, the route continues along the power line right-of-way on the east side of Buntzen Lake to the north end of the lake. The route then moves onto the sidehill on the side of Indian Arm, still generally following B.C. Hydro's 550 kv electric power line right-of-way. The route then passes along the steep rocky east side of Indian Arm to Grande Creek and Granite Falls, after which the route drops down to the existing roadway which starts on the east side of Indian Arm, north of Granite Falls. The pipeline follows this roadway along the upper part of Indian Arm into the Indian River valley across the Inlailawatash Indian Reserve #4 and then to the common point near the confluence of Hixon Creek and Indian River.

Route C: Indian Arm West

Route C is identical to Route B to north of Buntzen Lake. North of the lake, Route C diverges to the west, coming down to the shores of Indian Arm at a point north of Buntzen Bay, approximately 12.4 km from the Westwood Station. From this point, the route crosses Indian Arm by an underwater crossing. On the west side of Indian Arm the route proceeds for approximately 5 km to a gently sloping alluvial fan with a sand and gravel beach. From here Route C again crosses under Indian Arm to join Route B near Iron Bay on the east side of Indian Arm on the access road to the Indian River valley. Route C and Route B are common from this point to the confluence of Hixon Creek and Indian River.

Compressor Station

A compressor station is required for all alternatives somewhere near the take-off point from the B.C. Gas Inc. 20-inch pipeline. The Inquiry has not investigated the siting of the compressor station in any detail, but at its public hearings, heard on this topic from the Village of Anmore, the District of Coquitlam, GVRD Parks Department and Westbild Enterprises Ltd. Compressor stations can present special operating concerns related to air and noise emissions. These matters are taken into consideration in the evaluation of the alternative routes in the environmental and land use analysis presented in Chapter 6.

Pipeline Construction

All three of the alternative routes present significant difficulties in construction. These difficulties involve the amounts and complexities of rock excavation, stream crossings, steep gradients, unstable material, narrow access roads for construction, proximity to the electric powerline and underwater construction.

Figure 7 — Coquitlam watershed. General view of south end, showing area first logged in 1975 and now successfully regenerated. Pipeline routing follows road; this easy pipeline country extends for about five kilometres.

Figure 8 — Coquitlam Lake Dam. Water system intake is round tower at left. Pipeline route crosses dam and then follows road. Scar on hillside above road shows location of recent quarrying for dam maintenance.

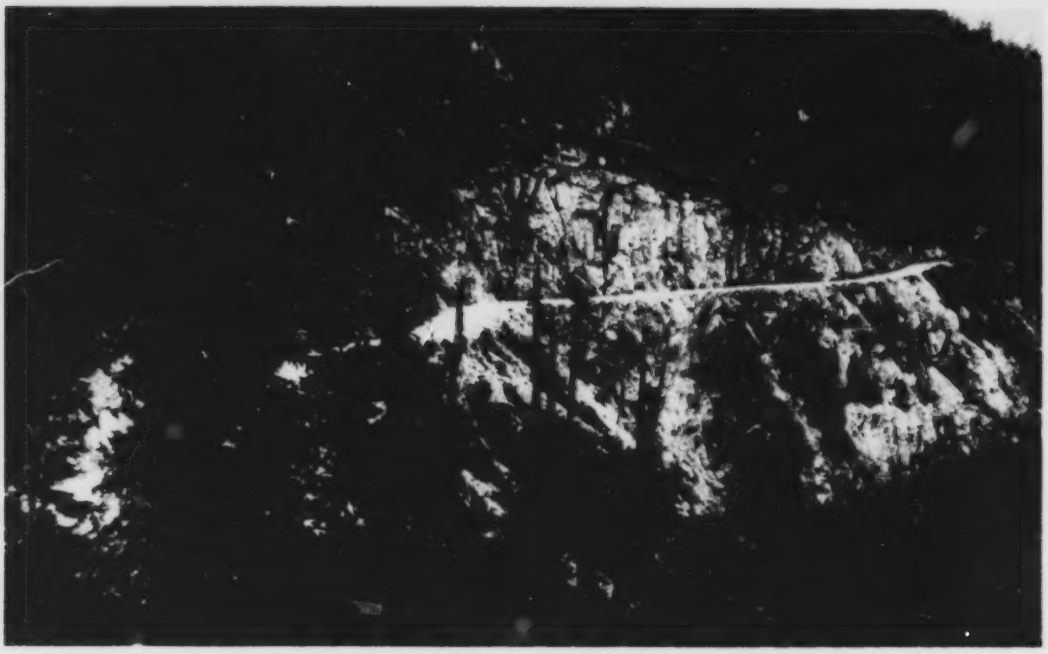


Figure 9 — Route alongside Coquitlam Lake. Narrow road gives pipeline crew little room to work when excavating road-ditch.

Figure 10 — Upper Coquitlam Valley near end of existing road five kilometres past north end of Lake. Pipeline route is road-ditch.

Route A: Coquitlam Watershed Route

On the Coquitlam Watershed route, the difficulties are to do with rock work, limited width of the road through the watershed, some unstable ground and the need to conduct activities and cross streams so as to protect water quality. All of the difficulties are obvious, visible from the existing road and can be identified in detail by a geotechnical examination during detailed design. All can be overcome by standard construction techniques. The largest problem is related to the limited room available on the existing road combined with the need to conduct all activities in a manner so as to protect water quality. Good planning will be needed to overcome the difficulties in a cost-effective manner.

The plan to place the pipe in a trench in the road ditch will be difficult to accomplish because of the lack of room in many places between the road ditch and the very steep side-slope immediately adjacent to the road. If this plan is to be followed and the road not destroyed, special excavation techniques will need to be used. Trench excavation will be slow and a large amount of preparatory work will be required. Rock scaling, rock bolting and pre-excavation of some earth and boulder slopes will be needed.

If the watershed route is to be followed, a detailed construction plan to include prepatory work, timing and scheduling of activity particular to each construction phase, as well as timing and scheduling of all other normal watershed activities, needs to be developed in conjunction with the GVWD. This construction plan needs to be part of an agreed overall water quality protection plan. In order to be effective in protecting water quality, this plan must be prepared by people with practical knowledge of rock and earth work as well as pipelining, must be agreed to by PCEC, the contractor and the GVWD and must be rigorously followed.

Construction of the watershed route using the existing watershed road and its extension is practical. The difficulties have been taken into account in the Inquiry Advisors' cost estimates.

Route B: Indian Arm East

The majority of the Indian Arm East route shows difficulties similar to the watershed route except for the requirement to protect water quality on the watershed route, and to protect the electric power lines and cottages on the Indian Arm route. The southern section to about km 14 has some modest increased difficulty because of the 550 KV powerline and its tower support. The northern section from about km 18.5 to km 26 is along an existing road and crosses some side channels of the Indian River. It is not a difficult section.

The section from about km 14 to km 18.5 presents extreme difficulties. First, the access is difficult and there is a large amount of rock work for both access and ditch excavation. The route follows a very steep side-slope with houses and cottages below. Control of fly-rock from blasting will be essential and difficult. Cut and fill is not possible over most of the route, and thus the contractor will need to haul a significant amount of excavated material. Dump sites are not readily available. Rock bolting will be required for short and long term stability, and protection of crews by anchoring wire mesh or other means will probably be needed on a day-to-day basis.

Second, there are some geologically unstable areas where a conventional surface route may not be feasible. Special techniques such as tunnelling or directional drilling will be

Figure 11 — Indian Arm — east side showing nearly vertical rock area, south of Granite Falls. The pipeline would be located approximately 100 metres above the powerline. This is part of the four-kilometre area of extreme difficulty, with waterfront cottages at the bottom of steep slopes.

Figure 12 — Indian Arm — east side at Grande Creek. Route would be located above powerline and falls in exposed bedrock.

Figure 13 — Indian Arm — east side. Part of four-kilometre section of extreme difficulty due to steep rock slopes, proximity of powerline, creeks and cottages.

Figure 14 — Indian Arm — east side. General view looking north from Lighthall Creek.

required. There are some talus slopes where specially engineered embankments will be needed.

Third, crossings of some of the deeply incised creeks are very difficult. Temporary bridges for access and aerial crossing for the pipe will probably be needed.

Fourth, one or more of the powerline towers will have to be stabilized, by reinforcing the foundations near the pipeline excavation by rock bolting or other means.

Finally, the 550 KV powerline will be an ever-present threat during construction, and during operation of the pipeline. The pipeline routes will be parallel to and will cross and recross the line of the conductors. Fly-rock control will be essential to avoid damage to the towers and conductors. Extreme caution will be needed during the work to ensure that equipment does not come in contact with or come too close to the conductors.

During construction, capacitive coupling as well as inductive coupling between the pipeline and the conductors will cause significant voltage in the pipe. After the pipeline is in place, induced currents from the 550 KV line will be a continuing problem, as will the possibility of ground faults from the line. The owner of the pipeline will need to use existing technology and perhaps develop new technology to deal with these problems, during both construction and operation. The same problem exists but to a lesser degree along the remainder of the pipeline through the Indian River valley where the route is parallel to and crosses the 550 KV line. A report on the subject of voltages in the pipeline by Bensted, Simpson & Associated Ltd., was submitted by PCEC providing more detailed information on this subject.

A report by M. Stepanek of Geo Engineering Ltd. was commissioned by the Inquiry. This report sets out the geotechnical concerns associated with the Indian Arm east route, and in general terms, suggests methods to overcome these difficulties. The cost estimate by the Inquiry Advisors takes into account the difficulties on this route.

The Commissioner concludes that construction of a 10-inch natural gas pipeline along the Indian Arm east route is practical, but will be expensive, time-consuming and dangerous.

Route C: Indian Arm West

The land section of the Indian Arm west route presents no unusual difficulties. The south and north sections are identical to the Indian Arm east route. West of Indian Arm the route has one steep section in rock, but by and large, is not of unusual difficulty.

The underwater crossings totalling 3.7 km have been preliminarily surveyed for the Inquiry.

This preliminary survey indicates that the crossings are feasible, but have difficulties which would need to be investigated further before a detailed design could be prepared.

At the east side of the south crossing, bed rock is exposed and slopes steeply to depth in the inlet. The landing surveyed is on private property near an existing house. This would need to be investigated in detail to find the best landing site and the site would require extensive preparation and restoration. Underwater blasting would be required down the slope and both special timing provisions and fish mitigation measures may be needed.

The soundings indicate large boulders over part of the underwater route. The extent of

Figure 15 — Indian Arm — west side. Location of southern underwater pipeline landing western shoreline. The foreshore rock would be blasted to locate a trench for the 1 700 metres of dual underwater pipeline.

Figure 16 — Indian River Estuary used by both Indian Arm East and West routes. The pipeline route would follow the eastern side of the valley. The wide valley bottom and estuary extends for seven kilometres northwards.

these needs to be confirmed and the boulders would need to be removed by blasting or other means. Fish mitigation measures may be required here as well.

There appears to be an underwater cliff on the east side more or less parallel to the sounding line. More detail would be needed to select a satisfactory alignment.

At the west side of the south crossing, the pipeline would reach shore through an alluvial fan. Stability of this fan would need to be investigated. Deep excavation may be required. Extensive restoration would be needed along with fish mitigation measures.

At the west side of the north crossing, the alignment enters the water through a gently sloping cobble beach. Stability would need to be investigated and extensive restoration and fish mitigation measures employed.

The underwater slopes of the north crossing are not extreme, but investigation of the alluvial fan of the Indian River and its potential effect on the underwater pipeline would be required. The pipeline crosses the inlet more or less perpendicular to Indian River. Seismic stability may be a problem.

The east side of the north crossing is not as steep as at the south crossing. Some underwater blasting would be required and stability investigations are needed.

In total, the underwater crossings appear feasible and represent the only significant unknown factor, on Indian Arm west.

The Inquiry Advisors' cost estimates have taken the difficulties and uncertainties of the underwater crossing into consideration.

The Commissioner concludes that construction of the Indian Arm west route is practical but would need further extensive underwater surveys and engineering to plan and construct properly and economically.

Pipeline Safety

One of the concerns leading to the Inquiry was to do with pipeline safety. Some of the submissions received by the Inquiry had to do with this subject. The Inquiry heard evidence about pipeline operations from Mr. James Colgan of the Provincial Pipeline Inspection Branch with responsibility for natural gas pipelines. Evidence was also received from Mr. Gavin Couper who appeared under the auspices of the Canadian Gas Association. This is a Canadian Association of over 500 members from the natural gas production, transmission, distribution and manufacturing industries.

Evidence was given on the requirements for natural gas pipelines to comply with Canadian Standards Association codes which govern safety aspects of design, construction and operation of gas pipelines in Canada.

Evidence was heard from Mr. Colgan that there are over 3900 kilometres of gas pipelines in British Columbia and from Mr. Couper that there are over 55,000 kilometres of natural gas transmission lines in Canada. The safety records of these pipelines is exemplary with one fatality recorded in the past ten years of records.

The main cause of natural gas pipeline accidents is third-party damage. Mr. Colgan testified:

> "MR. COLGAN: The majority of incidents have been caused by third party damage,

damage by people who had nothing to do with the pipelines; excavating, digging, scraping, bull dozing on the right-of-way without understanding what was beneath them." [Transcript, p. 152]

And by Mr. Couper:

"MR. COUPER: Similar experience to Mr. Colgan. Outside force damage due to third parties excavating is the principal cause of what we would call pipeline incidents." [Transcript, p.153]

The recent explosion of a gas pipeline in Russia was questioned and Mr. Couper testified about his knowledge of this incident:

"MR. COUPER: . . . There is no information that I have come across with regard to the cause, . . . and I should point out that it is not natural gas. It's a hydrocarbon, heavy hydrocarbon liquid pipeline." [Transcript, pp. 157-158]

And further:

"MR. COUPER: Heavy hydrocarbons are heavier than air and tend to settle around the location. If there is no wind, than the vapor will tend to spread around the area to ground level . . .

Natural gas is quite different. . . . It's almost half the weight of air and the natural tendancy for natural gas is just to go straight up in the air." [Transcript, p. 158]

There is no evidence that the operation of a natural gas pipeline through the watershed will have any effect on water quality. Evidence is that the primary concern is from third-party intervention with the pipeline. In the watershed where the GVWD has total control of all activities, the possibility of third-party damage is remote.

The pipeline will be designed, installed and operated to stringent code requirements, will be inspected regularly and will be in a closely controlled location. Therefore, the Commissioner is of the view that safety of the pipeline is adequately assured and warrants no further investigation.

CHAPTER 6

Environment, Land Use and Cost Considerations

The terms of reference directed that the Inquiry consider potential effects of the proposed pipeline on the quality of the natural environment. These considerations include effects on natural resources, recreational resources, visual impacts and impacts on residences along the pipeline route.

Additionally, the Inquiry assessed the impacts of the alternatives on existing and future land use along the pipeline right-of-way. Identification was also required of jurisdictions which may have responsibility for resources impacted by the pipeline, so that these may be dealt with in their areas of responsibility.

Environment and Land Use Review

To evaluate and report on environmental and land use impacts, the Inquiry retained Mr. Kenneth G. Farquharson, P. Eng. Mr. Farquharson has wide experience in environmental and land use matters to do with pipelines, electrical transmission lines, railways, mining projects and other civil engineering works.

Mr. Farquharson began his work by reviewing existing documents, followed by site visits, contact with federal and provincial authorities and commissioning of an expert report by an aquatic biologist. Throughout his work, Mr. Farquharson had continuous contact with other Inquiry Advisors as well as contact with the GVWD and PCEC.

Mr. Farquharson's report on some aspects of his work are contained herein as Appendix F. Other aspects were reported in his testimony to the Inquiry's public hearings on June 29, 1989.

The routes reviewed by Mr. Farquharson were Route D — Kilgard to Squamish, Route A — Coquitlam Watershed, and Routes B and C on the east and west sides of Indian Arm.

The Kilgard to Squamish route has been discussed earlier and reasons stated as to why it was not given further consideration. Part of those reasons is the significant environmental impacts identified by Mr. Farquharson and reported in Chapter 5.

On both the Coquitlam Watershed and Indian Arm routes, the Westwood Plateau Lands are impacted by the pipeline immediately adjacent to its origin on B.C. Gas Inc.'s existing pipeline at the Westwood Gate Station, as well as by the compressor station in the vicinity of the takeoff from the existing pipeline. This was noted by Mr. Farquharson and has been reinforced in the submission from Wesbild Enterprises Ltd. and others.

Route A: Coquitlam Watershed

In regards to the Coquitlam Lake route, the environmental problems were identified as mainly to do with turbidity issues which relate to water quality. Mr. Farquharson testified:

> "MR. FARQUHARSON: Coming to the Coquitlam Lake, it has been presumed in our review that the pipeline would cross

the Coquitlam River on the dam. If indeed this is not possible and there would have to be a crossing below the dam — which may cause some problems.

Going up the reservoir, the problems have been described as mainly geotechnical and turbidity issues which relate to water quality, and this is by far the dominant concern through the Watershed area. These just about limit the environmental aspects on that side.

MR. MacADAMS: My understanding is there's some concerns about the possibility of fuel spills and other difficulties, is that right?

MR. FARQUHARSON: Yes, this is correct. In reading the material, the two issues are a spillage of fuel and water turbidity.

MR. MacADAMS: Now, have you formed an opinion as to the level of risk that construction might entail in terms of creating turbidity in the lake?

MR. FARQUHARSON: Yes, I examined the historical record of measurements of turbidity in Coquitlam Reservoir during the period of GVWD operations in there for both road construction and logging, and it appears that their program has been successful in limiting turbidity, I think, to a high count of 5 NTU.

It was brought to my attention that there was a higher — an episode at which a higher record of some 22 NTUs observed, but this was due — could be defined as being totally due to a specific slide which occurred for natural reasons.

My assessment of this was that if construction activity could be limited to the same scale and managed under the same pattern as the GVWD had done, that the level of risk to turbidity and water quality in the reservoir should be comparable.

MR. MacADAMS: What was it that led you to — and I take it you're focusing on the level of activity defined in what terms?

MR. FARQUHARSON: I think the two issues are the number of people employed within the Watershed. I had picked up that it was of the order of 40, but I understand from the evidence given this morning that it may actually be somewhat less.

I think the second point is the type of work that is being done in the Watershed and, in my opinion, the work that would be required to prepare the bed for the pipeline and the installation of the pipeline are broadly analogous to the types of road-building and logging activity that the GVWD undertook on its own in the Watershed.

MR. MacADAMS: Is this a fair and accurate statement: That on a kilometre-by-kilometre basis that pipelining in the ditch of an existing road is less likely on a kilometre-by-kilometre basis to cause turbidity than would the creation of a road along the same terrain?

MR. FARQUHARSON: Yes, I would agree."

[Transcript, p.753]

In regard to land use and resource impacts Mr. Farquharson testified:

"MR. FARQUHARSON: Because of the nature of management of the area it is a closed area, therefore, the development in there, other than the water quality aspects, has very little impact on residents or visual aspects for people or conflicts with recreation, such types that people use. The nature of construction

there, whereby the . . . pipeline that's going to be placed in the bar ditch results in a very low reduction in the productive forest land base. These are some of the advantages.

MR. MacADAMS: Are there any others that come to mind?

MR. FARQUHARSON: No, I think those are the main points." [Transcript, p.758]

Route B: Indian Arm East

On Route B: Indian Arm East, Mr. Farquharson identified impacts on the Buntzen Recreation Area, visual impacts caused by the extreme rock cuts and clearing required along the hillside on the east side of Indian Arm, direct impacts from blasting and rock falls on the 80 recreational cabins on the east side of Indian Arm, disturbance to water supply to these cabins, salmon runs in the side channels crossed by the road in the lower Indian River valley, and impacts on the forestry resource.

In speaking about these impacts, Mr. Farquharson testified:

"MR. FARQUHARSON: Starting at the south, again, the route initially again crosses part of the Westwood Plateau lands, which have been sold for residential development. Then it goes through a portion of Crown land adjacent to the 500 kv line, in which there is no particular problem, and then enters the B.C. Hydro lands around Buntzen Lake.

Somewhere in this section of Crown land and the B.C. Hydro lands, a site will have to be found for a compressor station, which will end up inevitably being quite close to the highest use area in the Buntzen Lake Recreation Area, and also relatively close to the Village of Anmore. Some care will have to be taken in the siting and the design of this station.

Going along the east side of Buntzen Lake, construction would occur in the existing 500 kv right-of-way, but during the time of sort of peak use in summer, so there would be some disturbance to the public use of the Buntzen Lake Recreation Area. Passing the north end of Buntzen Lake —

MR. FARQUHARSON: Passing north of Buntzen Lake . . . the route moves onto the side hill on the east side of Indian Arm, still generally attempting to follow the 500 kv right-of-way. However, the terrain along here becomes very steep, very rugged, with rock-knobs and other things getting in the way, and it ends up having quite a struggle going along the east side of Buntzen Lake.

The problems that are caused are several. First of all, to allow pipeline construction there is a number of very high rock-cuts up to 15 metres high, which will certainly be highly visible from the waters of Indian Arm, or the far side.

Secondly, as the pipeline right-of-way diverges from the electric right-of-way, there will be quite large cleared swaths on that hillside, which will also be visible.

Thirdly, there is a string of approximately 80 recreation cabins along the east side of [Indian Arm]. This route will be on the side hill above them, and it will be very difficult in some instances to control the blasting and the rock removal without some threat to the cabins that are on the waterfront below.

These cabins also depend almost entirely on surface sources for their water, and the

nature of the construction and the inevitability of debris and other things entering the creeks will impair these water supplies during the period of construction, and for a recovery period thereafter.

Coming to approximately Granite Falls, the route comes off the side hill, and again, lies in the bar ditch of an existing logging road going up the Indian River valley.

There are important salmon runs in the Indian River, and the logging road crosses over certain side channels within which the pipeline will have to be constructed. And the Fisheries officials are concerned that, indeed, these side channels be protected and, if necessary, enhanced as a result of construction.

MR. MacADAMS: I understand there are some forestry impacts as well?

MR. FARQUHARSON: Yes. I have talked to the manager for this area in the Ministry of Forests' Chilliwack office, and he advises me that despite the steep side hill, that all the trees on this side are counted into the Annual Allowable Cut for his area, and that if he can get public acceptance, he proposes to cut them in the future, using helicopter logging.

MR. MacADAMS: In your opinion, what is the likelihood of his gaining that public acceptance?

MR. FARQUHARSON: Slim.

MR. MacADAMS: And what is the impact of the probability that forest will not be logged on the aesthetic considerations you earlier referred to?

MR. FARQUHARSON: I think the retention of as much forest as possible is desireable to try to conceal the joint rights-of-way, electric and pipeline, from the water level at Indian Arm.

MR. MacADAMS: You spoke of 85 recreational cabins. What effect, other than touching on their water supply, would you anticipate during construction on these 85 cabins?

MR. FARQUHARSON: On some of these cabins the slopes are so steep and the route is so relatively close to the cabins, that there is a danger from particularly rolling rock, uncontrolled, coming out of the rock excavations.

MR. MacADAMS: Would you anticipate interferences with water supplies to be permanent or temporary?

MR. FARQUHARSON: Temporary.

MR. MacADAMS: What environmental and land use advantages have you identified on this route?

MR. FARQUHARSON: The only significant advantage is that it keeps the pipeline out of Coquitlam Watershed."

[Transcript, pp.764-769]

Route C: Indian Arm West

Route C: Indian Arm West is identical to the East Route until about km 12 near Buntzen Bay where it diverges to the west going down to the waters of Indian Arm north of Buntzen Bay. The pipeline would then cross under Indian Arm to the west side where it is routed for about 5 km to the second underwater crossing at approximately km 20.4. At the north end of the northerly crossing of Indian Arm, the route again joins Route B. The underwater crossings are

through land held by the Crown Federal under jurisdiction of the Vancouver Port Corporation.

Mr. Farquharson testified about impacts peculiar to the Indian Arm West route:

"MR. FARQUHARSON: From the starting point to a point north of Buntzen Bay, they are identical to those for Route B. North of Buntzen Bay, the route descends from the 500 kv right-of-way to the water, and here we have the first inter-tidal crossing. This is in rock, and . . . there is a house on the private property quite close by. A considerable amount of blasting will be required at this particular location.

At the northern end of the southern crossing the pipeline comes ashore on a fan which has an inter-tidal area mainly of large cobbles. The Department of Fisheries and Oceans regards this as desirable habitat for young fish, and requires that these be restored approximately to their natural condition for the area.

We also discover from the habits of the various fish that use this area that there is a fairly tight window for the construction of the sub-marine crossings approximately six weeks from late July to early September. I should point out the young salmonids from the Indian River moved down past this way on the way to the sea.

On the west side of Indian Arm, there are fewer houses than there are on the east side, and if we total up the number of houses that Route C passes, it comes to some 20 cabins as compared to 80 plus on the east side. The forestry potential on the west side is rather better than on the east. The slopes are more gradual, and there is concern that there could be a loss of more productive forest land. However, it should be pointed out that it is possible to route on the west side largely along an old logging road, which is now overgrown, and thus not so severely impact the forest —

MR. MacADAMS: Could I ask that we focus for a moment on the 20 houses? Could you compare in terms of the quality in quantitative terms, the risks to the houses on the west side as compared with the risks to the houses on the east side?

MR. FARQUHARSON: Of these 20 houses along the total route, only some eight are located on the west side. The remainder are on the southern portion of the C Route on the east side, and the northern portion on the east side. On the west side, the slopes are less. The degree of rock, I understand, is also less. The amount of blasting will be less, so therefore I do not see the same danger to the houses on the west side as we have realized exists on the east side.

MR. MacADAMS: Please now continue, starting with the south terminal of the north crossing?

MR. FARQUHARSON: The south terminal of the north crossing is on a fairly gently sloping fan with a sort of a sand and gravel beach, which can fairly readily be restored following construction. But the north terminal is, again, a cobble beach, which will require a restoration after construction.

Following further north, the only remaining issue are the side channels of the Indian River along the road, as was for Route B.

MR. MacADAMS: What environmental and land use advantages have you identified on this route?

MR. FARQUHARSON: The major advantage is that it avoids the risk to the larger number of cabins on the east side of the Indian Arm. It avoids certain areas of instability on the east side which pose a potential threat to the pipeline. In one of the situations on the east side a tunnel is required with a considerable amount of spoil which has to be disposed of. We're not into that sort of situation on the west side. Those, I think, are the major advantages.

MR. MacADAMS: And the C Route shares with the B Route, the advantage you referred to earlier, that of not going through the Watershed?

MR. FARQUHARSON: That's correct."

(Transcript, pp. 773-776)

Mitigation Measures

In his work, Mr. Farquharson also gave consideration to mitigative measures which could be applied to each of the routes. These are summarized and listed as follows:

Route A: Coquitlam Watershed

- Preconstruction to the GVWD standards of the watershed road from the end of the existing road to the watershed divide.
- Preconstruction of perennial stream crossings in the watershed.
- The right of GVWD to close down construction under adverse conditions with adequate provision in the contract budget to cover this.
- Rental payments for use of the watershed road.
- Planning of forest activities so that these activities can desist during construction with compensation accordingly.

Route B: Indian Arm East

- Funds available to B.C. Hydro to provide extra facilities in the Buntzen recreational area to compensate for disturbance.
- Allowances for recreational cabin owners that may be at risk to ensure they are not in residence during construction.
- Protection of cabins and immediate repair of any damage.
- Restoration of water supplies.
- Measures satisfactory to Fisheries officials in regards to side channels to Indian River.
- Debris catchment basin in the steep creek immediately south of Granite Falls.

Route C: Indian Arm West

- As for the east route for common areas.
- Compensation satisfactory to Fisheries officials for blasting done in the intertidal zones for the underwater crossings.
- Effective restoration of beach areas affected by the underwater crossings.

Compressor Station

A concern of relevance to all the routes is the location and design of the compressor station

needed near the connection to the B.C. Gas Inc. 20-inch pipeline in order to raise the pressure for transmission of gas through the new pipeline.

Submissions were received from the District of Coquitlam, the Village of Anmore and Wesbild Enterprises Ltd. expressing interest and apprehension about the compressor station. Additionally, Mr. Farquharson in considering the impacts of alternative routes, asked for and received comments from B.C. Hydro and GVRD Parks Department about the compressor station.

All of the above-noted were concerned about noise impacts of the compressor station.

GVRD Parks, in responding to Mr. Farquharson's request for advice about a proposed location for the compressor station near the Ioco Industrial area, expressed opposition to this location because the pipeline from the compressor station would need to be routed through a part of Belcarra Regional Park. It was noted that Belcarra Regional Park is one of Greater Vancouver's most significant natural landscapes and visual impacts were of great concern.

In regards to the compressor station, it was noted by GVRD Parks that Sasamat Lake is "an unusually well protected site" and that "the noise will detract from the outdoor wilderness experience".

B.C. Hydro noted that the compressor station could affect equestrian staging areas and trails along with hiking trails and trail users. Noise on the main Buntzen Lake recreation area beach was also noted as a concern.

The Village of Anmore expressed concern about excessive noise pollution and stated opposition to any location in Anmore Village.

Both the District of Coquitlam and Wesbild Enterprises Ltd. presented briefs noting that residential development of the Westwood Plateau area has commenced and that the compressor station as preliminarily located would have major noise impacts.

Mr. Farquharson considered all of this information in his route evaluation and in respect to location of the compressor station testified:

> "MR. FARQUHARSON: Yes. It would be possible if routes B and C were used, not to start at the Westwood tap, but to start further west, either at the Anmore tap, or at the new tap near Ioco, on the existing B.C. Gas Transmission system. This might have some benefits in terms of cost and other impacts. However, it brings a new group of players into the consideration.
>
> If the Anmore tap were used, you would have to thread the pipeline through the Village of Anmore and locate a compressor station somewhere to the north of Anmore. This was considered by some to be maybe a bit of a difficult issue, and the suggestion was made that we should look further west . . . where the compressor station could be located in what is basically an industrial zone near Ioco.
>
> We determined that it would be feasible to put a compressor station in that area and to run a pipeline across the southeast corner of Belcarra Park, and the southern portion of the Buntzen Lake, but we felt it appropriate to ask the opinion of the GVRD parks people who manage Belcarra Park as to whether they felt this would be an appropriate solution.
>
> They replied in a letter . . . in which they advised us that they liked neither the possibility of running the pipeline across

the southeast corner of Belcarra Park, nor the location of a compressor station close to the southern boundary of the park.

MR. MacADAMS: In your opinion as a person who's dealt with these routing and location issues, is it possible to find a place to locate a compressor for the B and the C routes?

MR. FARQUHARSON: I believe a compressor station could be located and so designed as to be acceptable on those routes, yes."

Comparison of Routes

Finally, considering the environmental and land use impacts of the three routes, Mr. Farquharson testified:

"MR. MacADAMS: Mr. Farquharson, we've heard from representatives of residents of Indian Arm who expressed their concerns. Is there any possibility that either of routes B or C would destroy - and here I'm speaking of permanently destroy - the water supplies of those residents?

MR. FARQUHARSON: I don't believe so. They might destroy some of the facilities they've built to trap water, but I think these could be repaired and I think they would not harm the water quality in the longer term.

MR. MacADAMS: But I understand there might be some temporary interference, correct?

MR. FARQUHARSON: Correct.

MR. MacADAMS: Keeping in mind your conclusion that water quality in the Coquitlam Watershed can be preserved during construction at a level of risk no greater than is created by the forest management operations now carried out in the watershed, have you formed an opinion as to whether or not, in your view, any of routes A, B or C should be set aside as being unacceptable from an environmental or land use point of view?

MR. FARQUHARSON: No. I think all the routes could be constructed — or used and constructed within the limits of environmental acceptance.

MR. MacADAMS: And of those three routes, which, in your view, has the most severe environmental and land use impacts?

MR. FARQUHARSON: I consider Route B to have the most serious impacts.

MR. MacADAMS: Considering now routes A and C, as between those two, which do you say has the more severe environmental and land use impacts?

MR. FARQUHARSON: I consider overall that probably Route A has lesser impacts, given the conditions of the limiting of the construction activity to the present level managed by the GVRD in the Watershed.

MR. MacADAMS: As I understand it, you, as a consultant, walk into the maw of conflicts in land use, and is it fair to say that it becomes a balancing of interests?

MR. FARQUHARSON: Yes, that is correct.

MR. MacADAMS; And one of those interests, of course, is the costs that are involved by the action proposed?

MR. FARQUHARSON: Very much so.

MR. MacADAMS: In coming to the opinions you have just expressed, have you given any weight to the comparative costs of construction of routes A, B and C, and if not, why not?

MR. FARQUHARSON: I have not taken those into consideration, partly because I wanted to judge the issue entirely on the environmental and land use grounds, which was what I was asked to do."

[Transcript, pp. 778-782]

Mr. Farquharson's entire testimony which describes all of the work that he did along with his conclusions and recommendations are included in the Inquiry's Transcript, volume 4, pages 745-783.

Cost Estimates

Estimating the cost of major capital construction projects is not an exact science. Estimates and their accuracy depend upon many factors — information, procedures, training, judgement. The accuracy required of an estimate depends upon the purpose for which it is to be used. For the work of the Inquiry, it was important that estimates used to compare alternatives be founded on the same information base, prepared to an appropriate level of detail and identified as to the level of uncertainty. Thus, to enable comparisons to be made with confidence, the Inquiry's Advisors spent much time in preparing cost estimates for each of the routes examined in detail.

When the Inquiry started, estimates were available from PCEC and GVWD. PCEC had prepared estimates for the watershed route as part of its submission to the Utilities Commission. These were later modified to include the larger-diameter 12-inch pipe through the watershed which the Utilities Commission had recommended. PCEC had, in addition, made preliminary estimates of a proposed route along the east side of Indian Arm.

GVWD engineers had also made some preliminary appraisals of an Indian Arm east route and in May 1989 had retained Singleton Associated Engineering Ltd. of Calgary (Singleton) to review and compare pipeline routing through the watershed and on the east side of Indian Arm. As this comparison was being developed, GVWD engineers and Singleton identified a possible route on the west side of Indian Arm which, by two water crossings of the Arm, would avoid the very difficult sections on the east side.

Singleton's work was based on existing information. The PCEC watershed route estimate of $14.75 million was taken as a base for land pipeline costs, and difficulty factors were assigned to all three routes. This provided the basis to calculate estimates for the land portions of the Indian Arm routes. Singleton used the published estimate for the submarine section of the Vancouver Island Pipeline project to calculate, pro-rated on length, an estimate for the underwater work needed for the Indian Arm west route. These Singleton estimates were delivered to the GVWD on May 9, 1989.

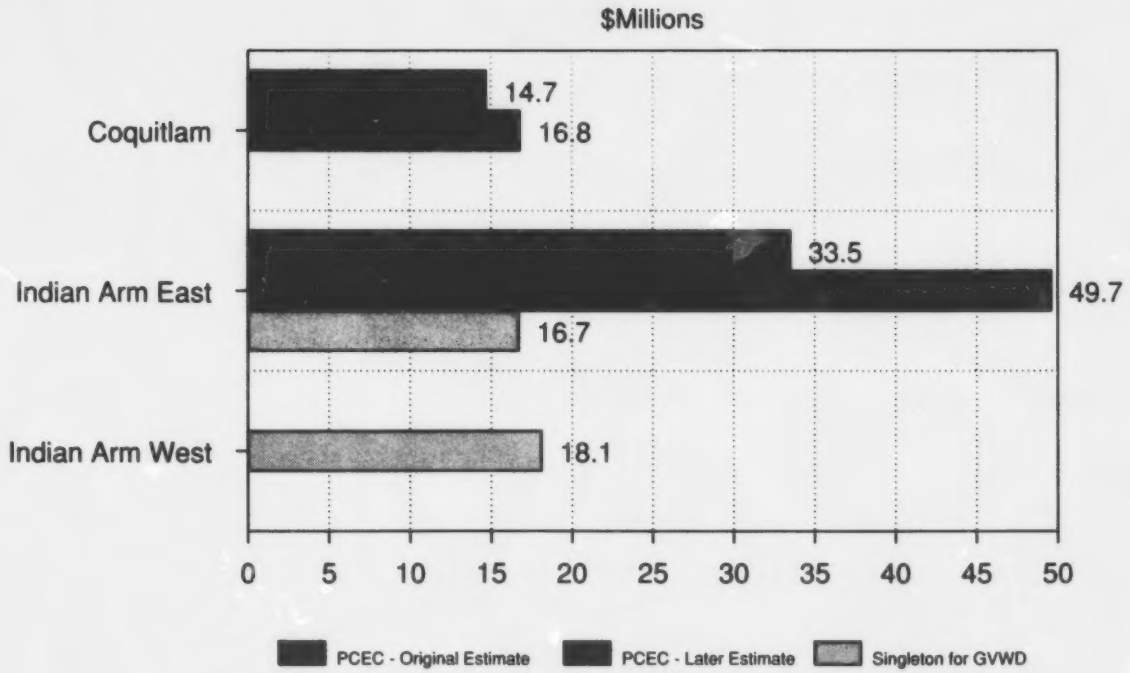
The estimates available when the Inquiry began are listed in Figure 17 and shown in graphic form on Figure 18. These estimates were made available by PCEC and GVWD in response to the Inquiry's information requests.

The Inquiry Advisors examined PCEC's proposed Coquitlam Watershed route along the watershed road from its origin in Coquitlam at km 0 to km 37.1 near the confluence of Indian River and Hixon Creek. Although some minor modifications along

Figure 17 – Cost Estimates Available When Inquiry Began – May 1989

	$
Coquitlam Watershed – Route A:	
PCEC – undated – part of submission to Utilities Commission	14,744,000
PCEC – undated – incorporates 12-inch pipe through the watershed as per Utilities Commission recommendation	16,783,000
Indian Arm East – Route B:	
PCEC – undated – with letter of January 10/89 to GVWD	33,524,000
PCEC – undated – in response to Inquiry Information Request	49,620,000
Singleton Engineering – May 9/89 – for GVWD. Comparative estimate based on PCEC estimate of $14,750,000 for Route A	16,724,204
Indian Arm West – Route C:	
Singleton Engineering – May 9/89 – for GVWD. Comparative estimate based on PCEC estimate $14,750,000 for Route A	18,099,228

Figure 18 – Cost Estimates at Beginning of Inquiry – May 1989



the route were believed to be worthwhile, these are not important in the overall consideration of costs. Accordingly, the PCEC route and location was agreed by GVWD and the Inquiry Advisors as the routing for which estimated costs would be prepared.

Similarly, on Indian Arm the routes were examined in consultation with PCEC and GVWD. Routes were agreed and mapped in sufficient detail to prepare estimates. The Indian Arm east route was determined following detailed consultation and review of the two routes which had been evaluated by PCEC and GVWD. This agreement on a common route was made possible because additional information became available from PCEC's geotechnical consultants and from ground reconnaissance by all parties. The finally-agreed alignment on the east side of Indian Arm required less rock excavation and is believed to be more suitable from a construction and safety point of view than either of the earlier alignments. Undoubtedly, more detailed investigation would lead to further refinement.

Agreement on the optimum routings was just one part of the non-adversarial and consultative approach which the Inquiry has followed and which Mr. Sharman, as principal technical advisor, established with GVWD and PCEC to review the routes and existing estimates, and to prepare final estimates of cost. Many cost items were agreed in this process. However, to agree on quantities and unit prices for much of the work proved impossible and thus a common agreed cost estimate for each route could not be produced.

Throughout the consultative process, PCEC maintained its position that the difficulties along the steep slopes of the east side of Indian Arm could only be overcome by expenditures of large sums of money and much time, while difficulties to be encountered in the watershed were minor and could be easily overcome. On the other hand, the GVWD maintained that the difficulties on the Indian Arm route were comparable to those in the watershed and that a road, similar to the watershed road, could be built on that route and at comparable cost.

On the Indian Arm east route significant differences of opinion continue. These centre around the very difficult terrain, the stability of the steep rock and talus slopes in the most difficult 5 to 6 km section along Indian Arm, and on the way to construct the pipeline in these areas.

On the Indian Arm west route there are minor disagreements on quantities and unit prices for some parts of the land sections. For the underwater crossing, there is insufficient information to reach a firm conclusion as to cost. Two independent estimates are available; one obtained by the Inquiry, and one obtained by PCEC. They vary widely. In any event, this route is not the most economical route in anyone's evaluation.

For the watershed route there are minor differences of opinion, principally about quantities of rock and the rate of progress of construction to be expected through the watershed. There are also some differences as to whether the pipe trench can be located in the road ditch and excavated to the neat lines proposed by PCEC.

When it became apparent that these differences could not be reconciled and that no agreed estimate would emerge from the consultative process, the Inquiry Advisors produced preliminary independent estimates by applying their own considerable experience and judgement to the information available. These estimates were produced and circulated to PCEC and GVWD on June 30, 1989.

After discussion of these estimates with GVWD and PCEC, it became clear that their differences of opinion had not changed significantly. In order for the Inquiry Advisors to be completely satisfied as to their conclusions, more geotechnical information was needed on all routes but particularly on the difficult sections along the Indian Arm east route.

Therefore, Mr. Milos Stepanek, P.Eng. of Geo-Engineering (MST) Ltd. of Calgary, Alberta was retained to provide the Inquiry with the necessary additional geotechnical advice. Mr. Stepanek is an experienced and well-respected specialist in the field of engineering geology and geotechnical engineering and has devoted special attention to stability problems, terrain analysis and evaluation of pipeline and transportation routes.

Aerial and on-ground examinations followed with special attention given the east side of Indian Arm as Mr. Sharman testified:

> "MR. MacADAMS: What caused you to trigger the further investigations on Route B installation costs?
>
> MR. SHARMAN: The biggest problem we run into on Route B is the controversy as to the quantity of rock and rock material that has to be moved.
>
> This is where the big problem has been in trying to arrive at a solution, and coupled with that, as I mentioned, the slow down of production doing the line.
>
> The first part of the line is difficult to a degree, but not like you get in this one section, and the north section of the line, having left Indian Arm, becomes relatively simple.
>
> And it's all these multitude of problems that caused us to re-estimate what we had originally started with. This resulted in the July 8th reconnaissance of the line, getting together with all the parties concerned, endeavoring to come to a conclusion of which we could then put a final estimate together."
>
> [Transcript, pp. 853-854]

As Mr. Naas, the Inquiry's expert advisor on rock work and excavation, testified:

> "MR. MacADAMS: You spoke of doing some on-the-ground review on Route B. How much walking did you and the other 10 or 11 people do?
>
> MR. NAAS: Extensive walking. I'm still aching. . . . we were lifted up to the line, up around kilometre 18, which is generally in the area south of what we call Granite Falls, at the beginning of a identified difficult section of Route B, and we walked through that area, including the area which had been talked about, [and we considered] various methods of construction including various types of tunnels, a creek crossing, which caused some concern, and talus slope, which . . . would be a construction problem, and identified bluffs, together with the geotechnical people who looked at strikes and dips, and I looked at the construction problem.
>
> MR. MacADAMS: And are you able to assure the Commissioner that you had opportunity, in terms of time and resources, to take as thorough a look at Route B as you think would be required for you to give advice to the Commissioner?
>
> MR. NAAS: . . . yes, I have, and we did a lot of work on Route B, because it was a contentious route in terms of some apparent real difficult construction problem. Therefore, we focused on it in some detail."
>
> [Transcript, pp. 819-820]

On July 19th the Inquiry advisors completed their evaluation of all routes and their final cost estimates were made part of the public record at the hearing on July 20th. The entire presentation of these estimates is included in Volume 5 of the transcript of the hearing, pages 787 to 887, and Mr. Sharman's report to the Inquiry is included as Appendix E, which has the detailed cost estimates attached.

While the Inquiry Advisors were working on their estimates, PCEC using its own staff, consultants and contractors made further cost estimates of all three routes and made them available to the Inquiry.

Similarily the GVWD, using its own considerable engineering and construction experience, along with advice from Thurber Consultants Ltd. geotechnical engineers, made another set of cost estimates for the three routes.

During all of this work, information was exchanged between the Inquiry, GVWD and PCEC and common definitions and formats for presentation were used.

All of the estimated costs now available for the Coquitlam Watershed route and the Indian Arm routes are shown in detail in Figure 19 and in graphical form on Figures 20, 21 and 22.

Figure 19 — Detailed Summary of Cost Estimates

Coquitlam Watershed — Route A

		$
PCEC Estimates:		
Undated — part of submission to Utilities Commission[1]		14,744,000
Undated — incorporates 12″ pipe through watersheds per Utilities Commission recommendation		16,783,000
July 19/89 to Inquiry		18,291,000
GVWD Estimates:		
July 20, 1989		20,596,000
Through Process of Consultation GVWD — Inquiry — PCEC:		
June 28/89[2]		18,119,000
Inquiry Advisor Estimates:		
Preliminary — June 30/89[3]		
Low estimate	15,558,000	
Most Probable Cost		20,252,000
High estimate	21,059,000	
Singleton Engineering — July 17/89		21,830,409
Final — July 19/89[4]		
Low estimate	19,445,000	
Most Probable Cost		21,170,000
High estimate	22,143,000	

Indian Arm East — Route B

		$
PCEC Estimates:		
Undated — sent to GVWD January 10/89[5]		33,524,000
Undated — sent to GVWD May 10/89[6]		49,670,000
July 19/89 — to Inquiry[7]		41,762,000
GVWD Estimates:		
Singleton Engineering — May 9/89[8]		16,742,204
July 21/89 — to Inquiry		21,212,000
Through Process of Consultation PCEC — Inquiry — GVWD:		
June 28/89[9]		32,355,000
Inquiry Advisors Estimates:		
Preliminary — June 30/89[10]		
Low estimate	22,691,000	
Most Probable Cost		24,108,000
High estimate	27,720,000	
Singleton Engineering — July 13, 1989		27,167,909
Final — July 19/89[11]		
Low estimate	25,840,000	
Most Probable Cost		29,667,000
High estimate	34,303,000	

Indian Arm West — Route C

PCEC Estimates:		
July 19/89		32,463,000
GVWD Estimates:		
Singleton Engineering — May 9/89[12]		18,099,228
July 21/89		28,049,000
Through Process of Consultation PCEC — Inquiry — GVWD:		
June 28/89[13]		26,734,000
Inquiry Advisors Estimates:		
Preliminary — June 30/89[14]		
Low estimate	21,470,000	
Most Probable Cost		24,063,000
High estimate	28,387,000	
June 18/89[15]		25,206,972
Singleton Engineering — July 15/89[15]		26,221,385
Final — July 19/89[16]		
Low estimate	27,227,000	
Most Probable Cost		31,252,000
High estimate	32,044,000	

Notes to Estimates – Route A:

[1] Filed as Exhibit 20 to Utilities Commission Hearings January – March 1989.
[2] Based on "best effort" by Inquiry to have PCEC and GVWD agree on quantities and unit prices. No agreement exists on major construction costs.
[3] Based on information available at June 30/89.
[4] Based on Inquiry Advisors' judgment of all information available at July 19/89 and independent geotechnical appraisal.

Notes to Estimates – Route B:

[5] Contained with letter of January 10/89 to GVWD.
[6] Received June 2/89 in response to Inquiry Information request of May 19/89.
[7] Filed by PCEC at July 21/89 Hearing. Estimate based on construction cost provided to PCEC by Majestic Contractors Ltd. and reviewed by Marine Pipeline Construction of Canada Ltd.
[8] Comparative estimate based on PCEC estimate for watershed route of $14,750,000 and access road cost provided by GVWD.
[9] Based on "best effort" by Inquiry and have PCEC and GVWD agree on route, quantities and unit prices. No agreement exists on major construction costs.
[10] Based on information available at June 30/89.
[11] Based on Inquiry Advisors' judgment of all information available at July 19/89 and independent geotechnical appraisal.

Notes to Estimates – Route C:

[12] Comparative estimate based on PCEC estimate for Watershed route of $14,750,000. Cost of underwater crossing estimated at two times the cost per kilometre estimated by PCEC for the underwater crossing to Vancouver Island with adjustment as recommended by Utilities Commission Interim Report March 14/89.
[13] Based on "best effort" by Inquiry to have PCEC and GVWD agree on quantities and unit prices. No agreement exists on major construction costs.
[14] Based on information available at June 30/89. Underwater crossing assumes dual crossings – cost based on Dillingham estimate adjusted – $5,557,000.
[15] Cost of underwater crossing: Dillingham estimate for dual crossings unadjusted – $4,763,000.
[16] Based on Inquiry Advisors' judgment of all information available at July 19/89; cost of underwater crossing based on Intec quote to PCEC less material and contingency; $9,400,000 for dual crossings.

Figure 20 – Coquitlam Watershed Route – 1989 Cost Estimates

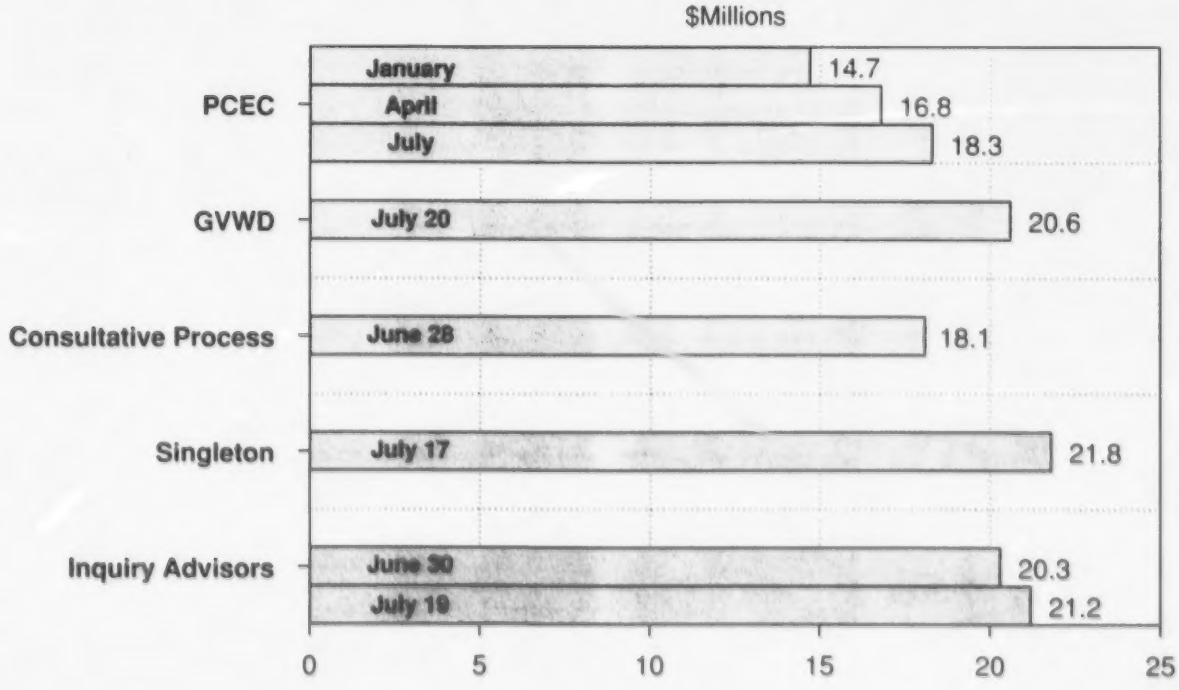


Figure 21 — Indian Arm East Route — 1989 Cost Estimates

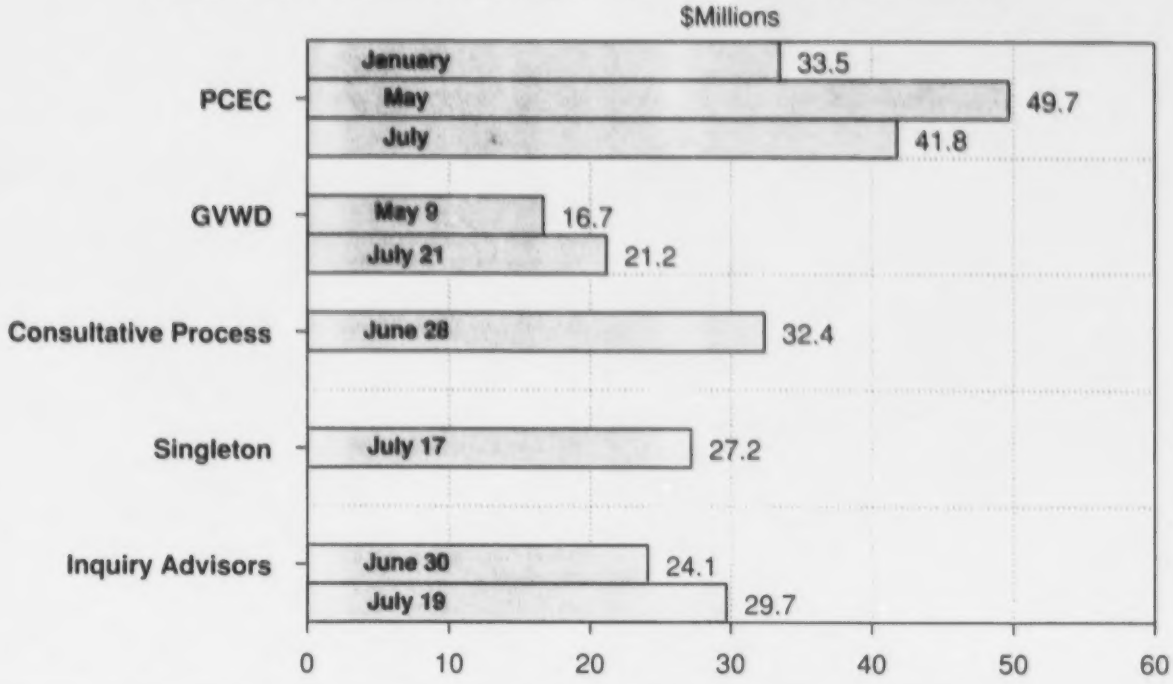
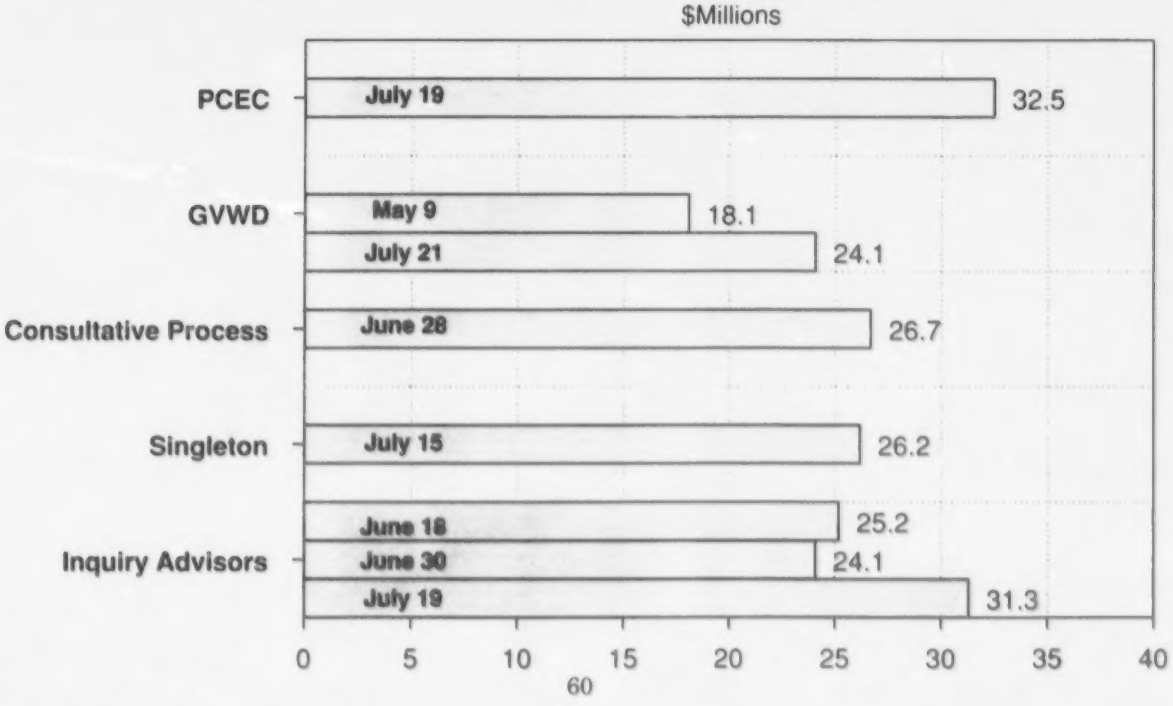


Figure 22 — Indian Arm West Route — 1989 Cost Estimates



Conclusion

As stated previously, estimating the cost of capital works is not an exact science. Rather, it depends upon the information available, the methods employed and the experience, training and judgement of those making the estimate.

In regards to the Inquiry Advisors' estimates, the information available has been extensive and the advisors have vigorously sought and obtained realistic information on which to base the estimates.

The methods employed by the Inquiry Advisors have been standard estimating procedures. Contingencies are included in their estimates of most probable costs. In addition, high and low estimates were made for each route to reflect the different levels of uncertainty each route presents.

The Inquiry Advisors all have extensive experience in the kind of work estimated and have applied this experience in an objective and unbiased manner.

In regards to the underwater crossing on the Indian Arm west route, the Commissioner is of the view that the Inquiry Advisors have adequately assessed the uncertainties and that their estimates provide a realistic estimate of the range of probable costs that could be expected if this route were actually built.

In regards to geological data to which the land sections of all routes are sensitive, the Commissioner subscribes to Mr. Stepanek's statement (Geo-Engineering Report, page 12): "Practical methods of geotechnical investigation in this terrain are limited. It is doubtful that more detailed investigations would provide a higher degree of confidence regarding the obtained results."

The Commissioner is satisfied that further rigorous examination of cost estimates will not change in any significant way either the rank order of the alternatives, or the range of the estimated costs provided by the Inquiry Advisors' estimates.

The Commissioner is also of the view that although costs were in part the genesis of the Inquiry and are important when public service and public money are involved, they are not the overriding issue here. Rather, water quality and public confidence are the critical issues.

CHAPTER 7

Water Quality Preservation Measures

Water quality is the critical issue. The Inquiry heard from the public about water quality and heard concerns that the integrity of the watershed would be impaired by the pipeline. The GVWD, from the beginning, was apprehensive about water quality impacts. The Administration Board of the Water District in its resolutions opposing the project specifically identified the need to obtain sufficient information on water quality.

For these reasons the Inquiry focused much of its attention on assembling facts about the possible ways that water quality could be impacted by the pipeline and on what measures could be taken to ensure preservation of water quality.

The potential risks to water quality have been identified in the evidence as:

- Turbidity caused by rainfall washing fine materials from construction activities into the lake, or caused from slides or other events occasioned by construction.
- Contamination from petroleum or other contaminants accidentally discharged during construction.
- Contamination from worker sanitary practices.
- Water system failure, or inability to deliver the required quantities of water, when the Coquitlam source is out of service because of construction activities.
- Unauthorized entry and potential for reduced security after construction.

The following section discusses each of these in turn, with the objective of determining what practical measures can be taken to preserve, or even enhance, water quality in both the short and long term.

Turbidity

The first item deals with turbidity. Evidence documented in previous chapters, shows that this is the most serious of the potential risks. Turbidity falls into two types: turbidity that may occur in the lake or river that settles out and does not reach the water intake; or turbidity that may occur in the lake and reach the water intake and thus impact on domestic water quality.

Turbidity is not in itself a risk to health, as has been noted previously and as Dr. Blatherwick testified:

> "DR. BLATHERWICK: That's right, you don't necessarily just because we have turbidity have a problem . . . we face that all the time, but the potential then for an introduction somewhere down that system into our system where our chlorine is not at maximum because of the turbidity and where the assault cannot be handled, that's really where my worries are."
>
> [Transcript, p. 342]

The amount and extent of a turbidity event is also of relevance, as Dr. Blatherwick noted:

> "DR. BLATHERWICK: We don't like to see it go over 5 [NTU] very often, but certainly its when it reaches 10 for any period of time. Just as a rough guideline, we've said three days; that 10 NTU for

periods of 3 days are what we do not want to see, because that poses the greatest risk.

MR. MacADAMS: But it's fair to say that periods of more than 10 NTU's for more than 3 days do not as a certainty pose a health problem, is that a fair statement?

DR. BLATHERWICK: Yes, it is. We have had those events as I pointed out from the evidence I previously gave, that in Capilano we have had higher than 10 NTU's. Our bacteriological counts at the tap have been acceptable and so the risk I am referring to is a theoretical risk and not something that has to happen all the time."

[Transcript, p. 336]

Route Above Km 12.5

Evidence is that beyond km 12.5 (about 5 km above the dam) the route along the lake is mostly in rock with minor occurrences of till and other fine materials. Turbidity is unlikely to be caused in this area unless work is underway during periods of very severe rainfall. Greater likelihood of turbidity is present during the crossing of perennial streams, where construction could release sediment which would flow to the lake. The turbidity from these sources would be relatively course-grained material which would settle out quickly.

In assessing the risk to water quality in the area above km 12.5, the Commissioner considered the large water volume in Coquitlam Lake, and the much smaller volume diverted through the water intake, and concludes that material released by construction would not reach the water intake except if there were sufficiently prolonged heavy rainfall as to cause discharge of water over the dam spillway. The effect of such spillage would be to move large volumes of water and any suspended material towards the GVWD intake. The Commissioner then examined rainfall and runoff records, and concludes that such an event is impossible if the lake is held at an elevation of at least 20 feet below the spillway, and the work is done in the late summer and early fall when prolonged heavy rainfall does not occur.

Some fine-grained materials also exist near the upper end of the lake and along the Coquitlam River above the lake. Again, however, turbidity could not reach the water intake if the lake is held well below top water level and the work is done in the late summer or early fall.

Thus the Commission concludes that pipeline construction above km 12.5 can occur with no risk to water quality from turbidity provided these two conditions are met.

Route From Dam to Km 12.5

Construction in the area from the dam to km 12.5, a distance of about 5 km, poses different circumstances and different potential risk.

Evidence is that there are significant fine-grained materials here and any discharge to the lake would be closer to the domestic intake tower. Therefore, more turbidity could easily reach the intake. With the best of care and planning, pipeline construction in this area could cause a turbidity event. From the historical record, it would be unlikely to exceed 5 NTU and very unlikely to exceed 10 NTU. However, measurable increase in turbidity is a possibility.

To eliminate any possibility of turbidity from pipeline construction in the area from the dam to km 12.5, the Coquitlam reservoir system should be taken out of service during construction in this area or standby

procedures should be in place to enable Coquitlam to be removed from service in a matter of hours.

Accidental Contamination

Contamination from petroleum or other contaminants accidentally discharged during construction is an ever-present possibility when workers and equipment are working in the watershed and using the watershed road. It cannot be prevented with certainty but can be controlled and risks avoided. Control measures include those now in place by the Water District for its own activities, plus careful monitoring of equipment, storage of fuel off-drainage, fueling of equipment outside the watershed or with small volume fueling equipment, lubrication changes done off-drainage and general good management and control.

With such measures in place and rigorously enforced, the risk of contamination from fuel or other materials would be equal to or less than that which exists from the present day-to-day operations. If spillage or an accident did occur, the results should not be measurable at the water intake. Particular care and control would be needed near the intake, but any risk is eliminated if the intake is out of service during construction in this area in order to avoid risk from turbidity as outlined above.

Worker Sanitary Practices

Contamination from worker sanitary practices is also an ever-present possibility when human activity is allowed in watersheds. The GVWD has a carefully thought-out, well-managed and stringently controlled program in place to deal with worker sanitation. This program was described by Mr. Jones:

"MR. MacADAMS: What are the main components of your watershed security system?

MR. JONES: Okay. As you mentioned, the watershed security is one of our barriers for assuring water quality, and what it consists of is controlling access and limiting access to those individuals who were involved in projects or work that's essentially a benefit to the district. When a person is designated by one of the departments . . . they are shown a video . . . which shows the potential for contamination of the water supply by the individual, and stresses the point that protection of the water supply is one of personal responsibility.

After they have seen the video, they are required to submit a stool sample. They are also given a copy of the watershed regulations. When the person enters the watershed, they must sign in to the watershed stating that they do not have diarrhea on that day and that they will use sanitary facilities and follow the watershed regulations. They also indicate where they will be working, and that they are going for a valid job; they're not just up there on a sightseeing tour.

Once they are in the watershed, we have the watershed security crew, and that's composed of the guards, and it's the guard's job — he's in a stationary guard house, and those are manned every day of the year, and his job is to make sure that the person coming in is going to a valid job and he has . . . the valid clearance to enter the watershed.

Once in the watershed, we have patrolmen, and their job is to make sure that once the person is in there, that he does in fact follow the regulations and carries out the work accordingly. They also

patrol the roads in the watershed, either in a vehicle or they will do it on foot as well, and look for trespassers that do enter the watershed.

Another job of the watershed security people is to provide sanitation facilities. This is a . . . potential source of pathogenic organisms, human waste, so we provide the sanitation facilities and the wastes are taken outside of the watershed and incinerated. So we cover that off as well."

[Transcript, pp. 276-278]

This same program with the same stringent enforcement that the Water District now demands for its own operations, if applied to pipeline construction, will ensure freedom from contamination from worker activities.

Source Interchangability

The water system as described earlier is an integrated system with water supplied from three separate sources, Capilano, Seymour and Coquitlam reservoirs. The Water District has documented and described in the evidence its long-term plan to provide source interchangeability; that is, to have the system capacity to remove any source from service during the off-peak months, in order to be able to carry out repairs or deal with seasonal water quality problems.

The GVWD now has limited capacity for source interchangeability. Evidence is that the capacity to take Coquitlam out of service is limited to a peak flow of about 50 million gallons per day, which represents the peak late fall and winter flows. This capacity was effectively demonstrated during the extensive shut-down of Coquitlam in the winter of 1987/88. The shut-down of Coquitlam is accomplished by using Seymour water supplemented by Capilano water, pumped to Seymour pressure through the Vancouver Heights Pumping Station.

In regards to Vancouver Heights Pumping Station, Mr. Morse testified:

"MR. MacADAMS: And in addition to the items which you identified on June 23rd, what capital expenditures do you say are required in order to achieve the objective [of source interchangeability]?

MR. MORSE: There are two items that are contained in the Seymour system . . . It's called the Vancouver Heights Pump Station upgrading. It's an old facility that is just over . . . 30 years old, and is in need of a major refit. That was anticipated to be done this winter. We are in the middle of a study to identify the exact scope of that work, but . . . there's an approximately million dollar refit required there.

[Transcript, p. 617]

And later, Mr. Morse continued:

"COMMISSIONER MacKAY: Yes, a couple of modest questions. Looking at this, not from the point of view of attempting to increase the transfer capacity of Seymour to Coquitlam, but looking at the safety aspects of what you're doing now, that is reducing the risk when you have that operation in effect, am I right that Vancouver Heights Pumping Station is high on that list?

MR. MORSE: Yes, very definitely, the very fact that we're in the middle of a study right now, yes, it's quite high on the list.

[Transcript, p. 626]

And further:

COMMISSIONER MacKAY: And a judgment call on your part, when you are in the transfer mode now with Coquitlam

out of service, and if Vancouver Heights went down, what situation would you be in?

MR. MORSE: Well, we would be in a situation where we could not supply Seymour headwater to parts of Vancouver. That's what the pump station does, it's Capilano water, and we would have to probably divert some Seymour water into the Vancouver area to be able to get that same head requirement in Vancouver. So . . . we would have to start to ration some of the Seymour system water that's available."

[Transcript, p. 628]

In addition to the major program at Vancouver Heights included in the capital expenditure program, the Water District has identified major maintenance and repair work which should be done at the Vancouver Height Pumping Station, if it is to be run for an extended period of time as part of the requirements to remove Coquitlam from service.

This work includes such things as overhauling the pumps and drives and replacement of engine bearings. Mr. Morse, in response to an Inquiry Information Request, estimated this work at $125,000.

Clearly this major maintenance of Vancouver Heights Pumping Station would increase the integrity of the water system if Coquitlam were taken out of service. To advance completion of this upgrading to the summer of 1990 is possible, and would be a benefit to the GVWD's system.

Unauthorized Entry

Unauthorized entry and potential for reduced security after construction is a potential problem because a pipeline right-of-way will open up new access routes to the watershed. These routes will provide access which is not now available for four-wheel-drive vehicles, motor bikes, horseback riders and hikers. This is of concern to the Water District as Mr. Morse testified:

"COMMISSIONER MacKAY: And if there were a right-of-way extended through there, would that concern you as far as security goes?

MR. MORSE: Absolutely. I believe those same expressions have been raised by the Greater Victoria Water District, but we are concerned about the increased readiness of access or accessibility on both ends of this particular pipeline project, the southern end and the northern end. The southern end is one that gives us a great deal of concern. The area right now up above Coquitlam is heavily used by, I'll say trail bikers and the like, and the only thing that keeps them out of the watershed in the south area there is the natural vegetation barrier.

We're concerned that if a right-of-way slashing through the timber, or whatever is done from the Hydro right-of-way, over towards the Coquitlam dam, that it is going to open up a very ready access for trail bikers, hikers, and the like, that is going to be very difficult to replace with the same level of effectiveness.

COMMISSIONER MacKAY: Yes, and how would you propose to deal with that if it came to pass?

MR. MORSE: Well, I think there's a number of ways in which we can do it. I think a person would be naive to think that putting a fence up is going to solve the problem. I believe we would be looking at an accelerated program of trying to restore the natural vegetation barrier as effectively as possible by importing

vegetation, or whatever is required, to be able to restore that barrier to the same level of effectiveness. It is not an easy problem.

That, compounded with a fence, you know, a very effective fence of, I'll have to say durable construction, is the only thing that we can see is likely to do that, other than perhaps a route change to get away from damaging the natural barriers that exist right now."

[Transcript, pp. 700-702]

The most effective measure to ensure protection against unauthorized access along the pipeline right-of-way, is to provide secure fencing and replant to restore the natural vegetation barrier as quickly and as effectively as possible. Additional patrols at the south end entry point may be required year round until the replanting program has fully taken effect, and may be required at the north end during the time when snow does not effectively preclude trespass.

Conclusion

Based on this examination of each of the areas of potential risk, their causes and most effective means of avoidance, implementation of the following measures will effectively preserve water quality during construction and operation of the pipeline:

- Construction from km 12.5 to the watershed divide in late summer or early fall with Coquitlam Lake at approximately 20' below top water level.
- Preconstruction of the crossings of perennial streams.
- Construction from the dam to km 12.5 with Coquitlam out of service.
- Careful control of equipment and fuel as specified above.
- Rigorous enforcement of watershed sanitary training procedures, monitoring and regulations.
- Advancement of the Vancouver Heights Pumping Station upgrading program.
- Provision of fencing and replanting of significant lengths of the right-of-way at the watershed boundaries.

To ensure preservation of water quality, activities in the watershed should be under the control of the Water District. One of the major disturbances of soil in the watershed would be during clearing and grading of the new access required for the pipeline from the end of the existing watershed road to the watershed divide. This work would best be done in a careful manner prior to pipeline construction. Rather than have this work done by a pipeline contractor it would be better done by the GVWD in its usual careful manner and to its usual standards prior to pipeline construction. Additionally, and to further protect future water quality, various long-term road improvements planned by the Water District such as replacement of wooden culverts and bridges with permanent concrete structures, should be done in conjunction with the pipeline construction. This will help to improve water quality at an earlier date and will preclude the necessity for these additional construction activities in the watershed later.

CHAPTER 8

Other Issues

Throughout its term, other issues were brought to the Inquiry's attention that did not bear directly on the terms of reference, but nevertheless need to be considered and dealt with.

These issues are other routes suggested to the Inquiry, the Greater Victoria Water District's concerns over the pipeline route through its lands, and matters relating to the provincial government's draft Energy Project Certificate for the Vancouver Island pipeline project.

Other Routes

The following were proposed:

- to route the Vancouver Island Pipeline through the United States using the Northwest Pipeline Limited facilities and to cross the Strait of Juan de Fuca from Green Point to Langford near Victoria;

- to route the Vancouver Island Pipeline from Coquitlam, underwater across Indian Arm to North Vancouver, through North Vancouver and the Capilano Watershed to Howe Sound and then underwater across Howe Sound from near Porteau to the Sechelt Peninsula.

These other routes represent alternatives to the Coquitlam Watershed. However, the proposal to route the pipeline through the United States is so far removed from the overall project with which the Inquiry is concerned, that consideration of it is beyond the terms of reference of the Inquiry. The pipeline referred to in the Order in Council is clearly the pipeline proposed by PCEC which was the subject of B.C. Utilities Commission hearings and the subject of a draft Energy Project Certificate. The alternatives referred to in the Order are alternatives to the route of this particular pipeline through the Coquitlam Watershed and not alternatives to the entire pipeline. Further, from the documents submitted in support of this route, it is clear that it was subject to a competitive review by government at an earlier stage and was rejected at that time. Accordingly, this submission is noted here and left on the public record for others who may wish to deal with it.

On the other hand, the second proposal, to route through North Vancouver and the Capilano Watershed can be considered within the terms of reference as an alternative to the Coquitlam Watershed.

The proponent for this route outlines advantages as follows:

- It would involve going through only 23 km of watershed that has relatively low geologic risk and virtually no rugged terrain.

- It would be by far the shortest route to the Sechelt Peninsula (about 58 km from Coquitlam, as opposed to about 80 km for the other two proposed routes) and would likely be the most cost-effective route (depending on the extra cost of laying underwater pipe across Indian Arm and Howe Sound). Furthermore, much of the route could follow existing roads (particularly through North Vancouver

and the Capilano Watershed) which would reduce the construction costs and the time needed to complete the project.

- Since the pipeline route would follow an existing gravel road through the entire broad, U-shaped Capilano River Watershed, there would be a minimal chance of disruptive surface disturbances in this watershed during construction. Also, since surface water in this drainage enters the Capilano Reservoir, any sediment would settle out before it entered the water intake pipes. Finally, if an accident did occur during construction, Vancouver could temporarily obtain its water from the Seymour and Coquitlam watersheds.

- This route would entirely bypass the geologically sensitive Stawamus River watershed area and would eliminate the possibility of contaminating a water intake system that has minimal settling capacity and one which must be used to supply all of Squamish's water needs.

- The underwater portions would involve laying a total of about 6 km of underwater pipe in less than 50 metres of water across Indian Arm and less than 70 metres of water across Howe Sound. Once across Howe Sound, the pipeline route could connect with existing logging roads that go from the town of Gibsons on the Sunshine Coast to Potlatch Creek on the west side of Howe Sound.

- This route would eliminate the need to cross the Squamish River and also to construct a pipeline over about 16 km of rugged, difficult-to-access terrain from Squamish to the vicinity of Potlatch Creek.

- A branch line from the main pipeline could be laid to Squamish and the pulp mill at Woodfibre.

- If the Howe Sound crossing was not viable, the pipeline could go from Furry Creek up the east side of Howe Sound and connect with the other proposed routes at Squamish (and thereby still bypass the Stawamus Watershed).

- To avoid the most densely populated areas in North Vancouver, the pipeline could be routed as high as necessary on the mountain slopes north of this area. Most of the rest of the route would avoid all populated areas.

The Inquiry made a preliminary examination of this proposal and concluded from that examination that is it unlikely there will be any saving in cost if present and potential future industrial customers in Squamish and Woodfibre are to be served from this route. In addition as was seen in the Inquiry's evaluation of Routes E and F in chapter 5 the environmental impacts of construction through the Anmore, Belcarra and North Shore communities are greater than the impacts of the route from Coquitlam directly to Squamish through the Indian River Valley. Further, the watershed impacts are, from the evidence presented to the Inquiry, more severe and more difficult to deal with in the Capilano Valley than those presented by the Coquitlam Watershed. Accordingly, this proposed route is also left on the public record for information.

Greater Victoria Watershed

The Greater Victoria Water District's submission to the Inquiry is identical to that which it filed with the Utilities Commission in its hearings on the Vancouver Island Natural Gas Pipeline. The District's concerns stem from the fact that the proposed pipeline traverses some seven

kilometres of its watershed lands. The District's concerns, from its brief, are listed as follows:

- Access to District Lands

  A 12 metre wide, 7 kilometre long corridor would be created through the District's lands. It is assumed that this corridor would include a maintenance road for use by pipeline personnel. The District is concerned that the corridor and its accompanying road would provide a route for hikers, hunters, motorcyclists and other vehicle operators who would persist in gaining access. Once inside the District's boundaries, trespassers have access to almost 350 kilometres of well-maintained logging access roads within the watershed areas. The presence of trespassers adds to the threat of watershed vandalism, forest fires and diminished water quality.

  It is very difficult for the District to locate, apprehend and remove unauthorized persons within such an extensive road network.

- Construction Impact

  The District assumes that construction of the section of the pipeline through its lands will take several months and involve large numbers of personnel and heavy equipment. The District anticipates that the construction will create a number of problems which have to be adequately addressed such as sanitation facilities, potential fire hazard, daily access and travel into the area by construction employees, fuel storage and accidental spills, and possible contamination of streams and creeks.

- Pipeline Security

  The District is concerned about pipeline security, particularly sabotage, vandalism and fire.

- Maintenance of Corridor

  The District is concerned as to the extent that the pipeline corridor would have to be maintained, and how this maintenance would be performed. Under no circumstances would the use of herbicides or any other pesticides be permitted.

- Liability Insurance

  The District assumes that it would still be entitled to continue its forestry and other operations in the vicinity of the proposed pipeline. The District is concerned that it would have to carry liability insurance to provide coverage against accidental damage of the pipeline by its operations. The District must also have assurances that Pacific Coast Energy Corporation will carry sufficient insurance to cover any damage incurred to District property, or loss of revenue, due to the malfunction of the pipeline during its operation, or during its construction.

- Flow Control in the Pipeline

  It is understood that the flow rates in the pipeline will be controlled from a computer located in Vancouver. The District is concerned that adequate backup procedures be in place in case of computer failure.

  The District also has concerns about the frequency and locations of shut-off valves within its land boundaries.

- Loss of Productive Forest Land

  As presently understood by the District, the proposed pipeline corridor would be approximately 12 meters in width and 7 kilometres long. The loss of this land to forestry production is of concern to the District as a considerable portion of the District's income is derived from forestry activities. The corridor may also tend to

alienate a portion of the District's land in such a way as to make it a non-viable forest management unit.

- Possibility of Second Corridor

  There has been considerable discussion by the Provincial Government about constructing another major highway on Vancouver Island. The route along which the proposed pipeline would be located coincides with one of the few feasible routes available for a major highway corridor. The District does not want two corridors to exist through its lands, and believes that if no other viable route may be found for the pipeline, it must be located in such a manner that it is not in conflict with any future corridor.

While these concerns have not been examined in detail by the Inquiry in reference to the Greater Victoria watersheds, recommendations are made based on the evidence submitted to the Inquiry which the Commission believes will adequately deal concerns of with the Greater Victoria Water District.

Draft Energy Project Certificate

In May 1989, after receiving interim and final reports from the B.C. Utilities Commission of its review and public hearings into the application of PCEC, the government issued a draft Energy Project Certificate. This document advised the public of the government's intention in regards to project certification and has allowed for further discussion and consultation.

One part of the draft Certificate consists of a section of eight clauses devoted to watershed protection which are reproduced as follows:

1. PCEC shall, with the participation of the GVWD and Greater Victoria (GVicWD) Water District, undertake studies of potential impacts of construction procedures in reservoir watersheds and incorporate mitigation measures into construction contracts prior to construction in these watersheds.

2. PCEC shall pay the costs of all monitoring by GVWD and GVicWD inspectors during construction, any additional costs to operate the water distribution system that are attributable to the Project, the costs of constructing or restoring barriers at new watershed access points to a level of effectiveness satisfactory to the respective Water Districts, and an annual cost determined by the GVWD towards maintenance of the existing road.

3. PCEC shall negotiate a long term agreement with the GVWD and GVicWD covering access and procedures involved in routine and emergency pipeline maintenance.

4. PCEC shall develop Water Quality Protection Plans acceptable to the GVWD and GVicWD, which may include bonding, to deal with potential damage to the Coquitlam and Victoria watersheds. The GVWD plan shall have four parts:

   a) environmental management program;

   b) water quality monitoring program;

   c) water quality and erosion control program;

   d) emergency response program specifying methods for clean up of spills and control of turbidity events.

5. PCEC shall temporarily cease construction of the project in the Coquitlam watershed upon the orders of the GVWD, if water quality of the

reservoir is determined by the GVWD to be adversely affected as a result of project construction activity.

6. With respect to construction through the Coquitlam Reservoir watershed, PCEC shall:

   a) carry out intensive soil sampling and particle size analyses during the detailed design phase, based upon a visual inspection of the pipeline route and a minimum of three samples analyzed per kilometre, or as frequently as considered necessary by the GVWD, for identification of small particle size till exposure in roadway cut sections;

   b) complete detailed hydrologic and geotechnical investigations, testing and design at stream crossings and debris flows to design site specific construction techniques and pipeline crossing criteria;

   c) construct the project with precise timing of the activities to be determined with the GVWD, when the Coquitlam source can be taken out of service should this be necessary to maintain acceptable water quality;

   d) negotiate with GVWD to provide a construction window during which the forestry hauling operations would be suspended while the project construction is proceeding and provide financial compensation for all costs and lost revenues caused by the suspension;

   e) carry out construction activity in the glacial till area from the dam to km 9 only during rain free periods, or if raining, if agreeable to the GVWD;

   f) prior to construction, require all construction, engineering and administrative staff who will have access to the construction site to receive a medical examination, interviews, and if necessary, medical testing to assure that they are free of communicable diseases which could be transmitted by water;

   g) require all construction staff prior to their employment on the site to receive instruction with respect to such activities as solid waste disposal, sanitary waste disposal and handling, environmentally acceptable construction techniques, fuel handling procedures, and other requirements that are appropriate to the Coquitlam Lake watershed;

   h) permit a GVWD employee or agent to be present on the construction site at all times with powers to cease construction temporarily, should rainfall be experienced which causes excessive turbidity levels as a result of construction activity;

   i) conduct continuous monitoring of turbidity at the intake, at points closest to construction activity, and at a lake station adjacent to km 9, and shall provide these data to GVWD, which may temporarily cease construction activity should intake turbidity levels approach 5 NTU or a higher level as may be permitted by the GVWD;

   j) adhere to all clauses in the GVWD watershed regulations manual, including sanitary and burning provisions.

7. PCEC shall install 323.9mm O.D. pipe through the Coquitlam Reservoir watershed in order to eliminate further intrusions for construction purposes should looping of the pipeline be required in the future.

8. Along the entire length of the project PCEC shall:
   a) take precautions acceptable to the Project Monitoring Committee to prevent siltation of surface waters;
   b) not store fuels or conduct oil changes in watersheds used for community water supplies;
   c) not locate construction camps in watersheds used for community water supplies;
   d) not deposit chemicals on roadways including salts, oils and other petroleum products;
   e) establish sanitary methods and practices of sewage and waste disposal as approved by the authorities having jurisdiction;
   f) advise the water purveyors including water utilities, water districts, Health Unit offices and Regional Water Managers of the Ministry of Environment of forthcoming project construction and location in watersheds at least two weeks prior to any construction activity;
   g) contact all users of licensed domestic and agricultural water withdrawn from streams crossed by the project and shall not unduly disrupt the water quality or quantity in regard to licensed water users; all concerns shall be noted in the Line List, and the PMC may direct PCEC to carry out mitigation measures and provide an alternate water supply to those affected and;
   h) for stream crossing, debris flow, and drainage culvert locations, prepare detailed construction drawings and specifications identifying specific construction conditions, techniques and showing details for mitigation measures.

In addition, the draft Certificate in Clause 12 establishes a Project Monitoring Committee with responsibility and authority as follows:

1. a) There shall be established a Project Monitoring Committee (PMC) comprising one representative of the federal Department of Fisheries and Oceans (DFO), one representative of the Engineering and Inspection Branch of the Provincial Ministry of Municipal Affairs, Recreation and Culture, one representative of the provincial Ministry of Environment, one representative of the Utilities Commission, and one representative of the Greater Vancouver Water District (GVWD);
   b) The authority of the PMC includes, but is not limited to, the following:
      i) the PMC shall establish procedures to ensure full compliance, by PCEC, with the conditions specified herein, and other environmental undertakings. Procedures shall accommodate the timing constraints of the project;
      ii) the PMC shall expeditiously adjudicate and resolve any conflicts among the various agencies involved and PCEC;
      iii) the PMC shall review and may amend PCEC's reporting procedures, to maintain cost control surveillance and performance of construction to schedule;
      iv) the PMC shall determine, in consultation with PCEC, the numbers of field inspectors acting on behalf of the Ministry of Environment, DFO and the

Ministry of Municipal Affairs, Recreation and Culture;

v) the PMC shall have the authority to order that specific construction activities of the project be temporarily ceased;

vi) the PMC shall ensure that the results and recommendations of studies are satisfactorily incorporated into final design and construction by PCEC;

vii) the PMC shall ensure that PCEC's commitments to surveys, studies, public consultation programs and environmental procedures are completed in a satisfactory and timely manner;

viii) the PMC may take recommendations to the Deputy Ministers of Energy, Mines and Petroleum Resources and Environment prior to the exercise of their powers pursuant to Part II of this Energy Project Certificate.

These provisions of the draft Energy Project Certificate are extremely thorough and comprehensive. They are based on the hearings, reports and recommendations of the B.C. Utilities Commission and the review of involved government agencies. The sections on watersheds are particularly responsive to the concerns raised by the GVWD at the Utilities Commission's hearings.

Evidence to the Inquiry has confirmed the adequacy of the provisions in the draft Certificate insofar as they relate to the Coquitlam Watershed. Accordingly, the Commissioner subscribes to and endorses those provisions of the draft Energy Project Certificate. The detailed recommendations made in this report amplify those provisions and, in the Commissioner's view, can be accommodated without amendment to the existing draft Certificate.

Regarding the Project Management Committee, it is the Commissioner's view that the Project Management Committee should not be given authority over activities in the Greater Vancouver or Greater Victoria Watersheds. The Water Districts, with the exception of statutory authority of other bodies, should have absolute control over activities within their watersheds. Accordingly, there is no need for the GVWD to be represented on the Project Management Committee.

Appendices

APPENDIX A-1

Commissioner's Terms of Reference

SCHEDULE
TERMS OF REFERENCE
Watershed Inquiry

1. A Commission be issued appointing Douglas L. MacKay of West Vancouver, as a sole Commissioner, pursuant to Part 2 of the *Inquiry Act*, to enquire into and report, prior to July 30, 1989, on all matters associated with the proposed routing, construction and operation of the Vancouver Island Natural Gas Pipeline (the Pipeline), through the Coquitlam Watershed and alternatives thereto. Without limiting the generality of the foregoing, but as an aid to the Inquiry, the Commissioner is directed to enquire into, investigate, review and report upon:

(a) whether the Pipeline should be constructed and operated in the Coquitlam Watershed;

(b) alternative routes to the Coquitlam Watershed route for the construction and operation of the Pipeline, if considered appropriate by the Commissioner;

(c) potential adverse effects of the construction and operation of the Pipeline on the quality of the natural environment, public health or safety, water supply quantity, quality or reliability and the practices, conduct, objectives, standards or means necessary by which they may be acceptably reduced or mitigated;

(d) terms and conditions for construction and operation of the Pipeline through the Coquitlam Watershed or an alternative route, if so recommended, including those necessary to ensure the safe, prudent and environmentally acceptable construction and operation of the Pipeline;

(e) construction practices, timetables, cost estimates, and pipeline reliability requirements recommended for the route ultimately recommended by the Commissioner for the Pipeline.

2. The remuneration and allowances of witnesses who are required for the purposes of the Commission, in respect of mileage and maintenance and other incidental and necessary expenses, including travelling expenses, be on the same scale as provided in the Rules of Supreme Court of British Columbia.

3. Consent is given to the Commissioner appointing a secretary, clerks, stenographers and research assistants as he considers necessary for conducting the Inquiry and to pay them at the rate or salary that is equivalent to the rate or salary paid to employees in similar positions in the public service and the Commissioner may appoint consultants or advisors as he considers appropriate and the Commissioner may establish rates, fees, living and travelling expenses to be paid such positions.

4. The Attorney General may appoint counsel to the Commission, and may establish the rates, fees and expenses to be paid to Commission counsel.

5. Subject to appropriation, approval is given to government to pay all expenses incurred by the Commissioner in the Inquiry and which are considered necessary by the Commissioner for the proper carrying out of his duties.

6. Remuneration of the Commissioner is set at $100 for each hour of involvement in the Inquiry. Living and travelling expenses shall be paid to the Commissioner equivalent to the rates paid to Group III managerial employees in accordance with Treasury Board Order 88, and that clerks, stenographers, research assistants and similar employees be paid equivalent to the rates paid to Group II employees in accordance with the said Orders, for each day during which they are engaged in the performance of the powers and duties of the Commission.

APPENDIX A-2

Commissioner's Oath of Office

County of Vancouver

Province of British Columbia

Canada

IN THE MATTER OF:

Inquiry Act

RSBC 1979 Chapter 198

AND IN THE MATTER OF:

Douglas L. MacKay,
Commissioner

COMMISSIONER'S OATH OF OFFICE

I, DOUGLAS L. MacKAY swear that I will truly and faithfully execute the powers and trusts vested in me by His Honour the Lieutenant Governor in Council under the *Inquiry Act*, according to the best of my knowledge and judgment.

So help me God.

Douglas L. MacKay

Sworn and subscribed by the said Douglas L. MacKay at Vancouver, British Columbia, this 24th day of May, 1989 before me:

APPENDIX B-1

Location, dates and counsel — Inquiry Public Hearings

Location: All hearings took place at 4595 Canada Way, Burnaby

Dates:

June 22, 1989	June 29, 1989
June 23, 1989	July 20, 1989
June 28, 1989	July 24, 1989

Counsel at the hearings:

Douglas MacAdams, Inquiry Counsel

Chris W. Sanderson, Pacific Coast Energy Corporation

Stephen Schachter, Greater Vancouver Water District

APPENDIX B-2

Witnesses/submittors/participants — Inquiry Public Hearings

Witnesses:

James Colgan
Gavin James Couper
John R. Morse
Edward Hamaguchi
Robert J. Jones
Dr. John Blatherwick
Dr. R.N. Dawson
Gregory J. Kirmeyer
Ken Farquharson
Drummond Cavers
John Kavanaugh
Henry Yamauchi
Robert Sharman
Olav Naas
Milos Stepanek

Submittors:

Mayor Ney — City of Nanaimo

Ald. S. McKinnon/C. Wright — District of Surrey

N. Neyberg — District of Coquitlam

E. Ward — Northeast Coquitlam Ratepayers Association

Ald. P. Blackman — Village of Anmore

M. Woodward — District of Powell River

D. Schmit — Indian Arm Ratepayers Association

Mayor P. Turner — District of Squamish

M. Goodman

H. Fletcher — Sechelt Indian Government District

Ian Waddell, MP

K. McCallister

D. Findlayson — Nanaimo Natural Gas Pipeline Committee

J. Thomas — Inlailawatash Indian Reserve

Walter Ohirko

John Harter

Participants In Writing:

David J. Gilmour — Vancouver

J.G. Roberts — Port Coquitlam

A.R. Greenhalgh — Vancouver

Phillip A. McNulty/William J. Barnes/ Joseph P. McLean — Vancouver

James T. Allard, Vice President — Allard Contractors Ltd. — Port Coquitlam

Geoff Matthews, Chairman — Nanaimo Natural Gas Pipeline Committee

Don Silvester, Chairman — Powell River Regional District

Greater Victoria Water District — Victoria

D.H. Rudberg, Deputy City Engineer — City of Vancouver

Carole E. MacLean, Council of the City of Port Moody

City Manager — City of Port Alberni Regional District of Alberni-Clayoquot

Mrs. D.R. Comis — Corporation of the District of Burnaby

S. Smith — Squamish & Howe Sound Chamber of Commerce

W.J. Blakely, P. Eng.

Francis J. MacNaughton — Vancouver Port Corporation — Vancouver

Robert V. Ostler — District of Campbell River

Mayor Don Lockstead — District of Powell River

Elizabeth Keller & Brian Lupton — Victoria

Frank W. Baumann, P. Eng. — Squamish

Mark W. Rose, MLA/ John Cashore, MLA/ Anne Edwards, MLA

Barbara Copping, M.D. — Board of Trustees — School District Number 43 — Coquitlam

Stanley P. McKinnon

W.D. Thorneloe, P. Eng. — Wesbild Enterprises Ltd.

Other participants

B.C. Gas Inc.
Council of Forest Industries (COFI)
S.P.E.C.
B.C. Enterprise Corporation

APPENDIX B-3

List of Exhibits at Inquiry Public Hearings

1. Red three-ring Binder containing written submissions to Inquiry

2–7. Maps submitted by City of Coquitlam

8. Statements and copies of correspondence submitted by Northeast Coquitlam Ratepayers Association

9. Text of presentation submitted by District of Squamish

10. Correspondence and statements submitted by Mr. Walter Ohirko

11. Map of alternative pipeline routing submitted by Mr. Walter Ohirko

12. Blue three-ring binder containing 18 documents relating to pipeline reliability, watershed management, water quality

13. Statement submitted on behalf of Ian Waddell, MP, by Mr. M. Farnworth

14. Correspondence and resolution from Village of Anmore presented by Alderman Pamela Blackman

15. Submission from Corporation of District of Powell River presented by Michael Woodward

16. Map entitled "Coquitlam Source Distribution Areas"

17. "Drinking Water Quality Impact Assessment Report," prepared by Economic and Engineering Services, Inc. for Greater Vancouver Regional District

18. Robert N. Dawson, Curriculum Vitae

19. Gregory J. Kirmeyer, Curriculum Vitae

20. Green 3-ring Binder containing 14 documents *re* PCEC selection of Coquitlam Watershed routing, etc.:

- PCEC Application Volume 1 Application/Engineering November 1988, Table 6 "Design and Capacity of Facilities." (Ex. 3 at BCUC hearings)
- PCEC Application Volume 3 Procedures Manual for Environmental Engineering November 1988, Table 2, pp. 1 to 15, "Route Selection and Project Design." (Ex. 5 at BCUC hearings) (Inquiry Document PCEC 4)
- BCUC Staff Information Request and PCEC response (Ex. 20 at BCUC hearings) (Inquiry Document BCUC B-1)
- Rules of Practice and Procedure of the National Energy Board, Schedule II Information Requirements Part VI Environmental Information, Appendix, PCEC Application Volume 3 Procedures Manual for Environmental Engineering November 1988 (Ex. 5 at BCUC hearings) (Inquiry Document PCEC 4)
- Community watersheds crossed by Westcoast Energy Inc.'s Pipelines
- PCEC application dated October 12, 1988
- PCEC amended application dated December 14, 1988
- Coquitlam Lake Water Reserve Activity Report (Ex. 40 at BCUC hearings) (Inquiry Document PCEC 6)
- Submission to Greater Vancouver Regional District, March 3, 1989 (Inquiry Document PCEC 2)

- Stream crossings list supplied by PCEC
- PCEC Contract Documents April 1989 Volume 1 of 2, Table 5, "Project Description," pp. 10 to 15
- Hardy BBT Limited, Report of Geotechnical Conditions, January 21, 1989, Table 1, pp. 1 to 4
- Hardy BBT Limited Report of Geotechnical Terrain Considerations for Proposed Natural Gas Pipeline through Coquitlam Watershed, February 22 1989, Table 1, pp. 1 to 3
- Vancouver Island Natural Gas Pipeline, Draft Energy Project Certificate, May 1989

21. Draft GVWD document containing Capital Expenditure program, dated June 28, 1989

22. Photographs of activities in Coquitlam Watershed, June 17, 1989, Hardy BBT Ltd.

23. Recent Photographs of Route Along Coquitlam Lake, June 11, Hardy BBT Ltd.

24. "Draft for Consideration by Council *re* Proposed Natural Gas Pipeline," dated June 16, Village of Anmore

25. Black three-ring binder containing 25 documents *re* consultant studies and detailed cost estimates for Routes A, B and C. Cost Estimates — Routes A, B and C — Consultative Process:
    - Cost Estimates — Route A — Low/ Most Probable/High — Inquiry Advisors: with explanatory note
    - Cost Estimates — Route B — Low/ Most Probable/High — Inquiry Advisors: with explanatory note
    - Cost Estimates — Route C — Low/ Most Probable/High — Inquiry Advisors: with explanatory note
    - Robert S. Sharman — curriculum vitae
    - Olav O. Nans — Qualifications and Experience
    - Milos Stepanek — curriculum vitae
    - "Pipeline Routes in and Around Coquitlam Watershed" — Geotechnical Report to Douglas L. MacKay, P. Eng., Commissioner — prepared by Geo-Engineering (MST) Ltd. — July 1989
    - "Vancouver Island Pipeline Project Pipeline Capital Cost Estimate Coquitlam Lake — Alternate A" — prepared for Coquitlam Pipeline Inquiry by Singleton Associated Engineering Ltd. — July 17, 1989 —
    - "Vancouver Island Pipeline Project Pipeline Capital Cost Estimate Indian Arm — Alternate B" — prepared for Coquitlam Pipeline Inquiry by Singleton Associated Engineering Ltd. — July 13, 1989
    - "Vancouver Island Pipeline Project Pipeline Capital Cost Estimate Indian Arm — Alternate C" — prepared for Coquitlam Pipeline Inquiry by Singleton Associated Engineering Ltd. — July 18, 1989
    - "Vancouver Island Pipeline Project Pipeline Capital Cost Estimate Indian Arm — Alternate B" — prepared for Coquitlam Pipeline Inquiry by Singleton Associated Engineering Ltd. — July 15, 1989
    - Dillingham Construction Ltd. — Letters with summary of budget price estimate for Indian Arm submarine crossings — June 15, June 16, 1989

- "Hydrographic Survey of two potential pipeline routes across Indian Arm, Vancouver, British Columbia" — McElhaney Geosurveys Ltd. — June 1989
- Pipeline Contractors Association of Canada — Letter giving wage and employer contribution charges applicable to Vancouver Island Pipeline project — June 20, 1989
- Commonwealth Seager Group Consulting Corrosion Engineers — Letter outlining hazards and methods of circumvention for powerline/pipeline proximity — June 16, 1989
- "Proposed Natural Gas Pipeline in Coquitlam Lake Watershed Geotechnical Assessment" — report to Greater Vancouver Regional District — Thurber Consultants Ltd. — Feb. 16, 1989
- "Vancouver Island Natural Gas Pipeline Assessment of Coquitlam Lake and Indian Arm Routes" — report to Greater Vancouver Regional District — Thurber Consultants Ltd. — July 7, 1989 —
- Pacific Coast Energy Corporation — Capital Cost Estimate — Vancouver Island Pipeline B.C. Gas — Coquitlam Lake Route and Indian Arm Route — with notes on methodology
- Pacific Coast Energy Corporation — five contractors bids — response to Inquiry Information Request No. 3
- Hardy BBT Limited — Letter to Westcoast Transmission Inc. *re* Estimate of Rock Ditch and Slashing Quantities along Coquitlam Lake — February 17, 1989 — response to Inquiry Information Request No. 3
- Intec Engineering Inc. — Indian Arm Pipeline Crossings Cost Estimates — 22 June 1989
- Gobin Construction Ltd. — Letter to Westcoast Energy Inc. giving cost quotation for construction of Indian Arm East route — June 19, 1989
- Marine Pipeline Construction of Canada Ltd. — Letter *re* Coquitlam Watershed Pipeline Inquiry — Proposed Route B on East side of Indian Arm reviewing construction difficulties and costs — July 18, 1989
- Pacific Coast Energy Corporation — Coquitlam Watershed Inquiry Cost Estimates — Routes A, B and C with explanatory notes — July 19, 1989

26. Photographs of "Indian Arm — Commission Route," Hardy BBT
27. Report on Electrical Interference Hazard Associated with proposed Indian Arm pipeline route by Bensted, Simpson & Associates for Pacific Coast Energy Corp. — July 1989
28. Majestic Pipeline Construction computer print-out of bid documents
29. Photographs of Routes A, B and C with map showing photo locations, Geo-engineering (M.S.T) Ltd.
30. Watershed Soils samples test results — Seymour, Capilano, Coquitlam
31. Red three-ring bider No. 2 containing further written submissions to Inquiry

APPENDIX C

Commissioner's Statements and Public Advisory Notices

Commissioner Statements:

29 May 1989:	On beginning work and opening Inquiry office; public input sought.
3 June 1989:	Setting date for hearings; advisory seeking input.
14 June 1989:	On response to Hearing Notice, phasing of hearings, issuance of Public Advisory Notes 1–7.
22 June 1989:	Opening statement to public hearing.

Public Advisory Notes:

3–10 June 1989:	Public Hearing Notice advertisement placed in major and local newspapers.
16 June 1989:	No. 1 — Map of route alternatives: Coquitlam Lake and Indian Arm.
16 June 1989:	No. 2 — Summary of water-quality issues being considered by Inquiry.
16 June 1989:	No. 3 — Summary guidelines for participants.
16 June 1989:	No. 5 — List of Inquiry's expert advisors.
16 June 1989:	No. 6 — Advice to media.
21 June 1989:	No. 7 — Schedule for Inquiry hearings 22 June 1989.
27 June 1989:	No. 8 — Schedule for Inquiry hearings 28 June 1989.
28 June 1989:	No. 9 — Extended route map.
29 June 1989:	No. 10 — Schedule for Inquiry hearings 29 June 1989.
17 July 1989:	No. 11 — Schedule for Inquiry hearings 20 July 1989.
21 July 1989:	No. 12 — Schedule for Inquiry hearings 24 July 1989.

APPENDIX D-1

Information Supplied in Response to Inquiry Information Requests by B.C. Utilities Commission

A-1 List of Exhibits from BCUC hearings

A-2 Hardy BBT Limited Geotechnical Reconnaissance of Route from Coquitlam Lake to Brandt Creek via Indian Arm (December 23, 1988)

A-3 Supplementary Photos of Route Up Indian Arm

A-4 PCEC — Effect of Siltation on Chlorination Systems Given by Mr. Kavanagh

A-5 GVRD — Drinking Water Quality Impact Assessment Report — February 16, 1989

A-6 G. Kirmeyer — Construction-Related-Impacts on Water Quality

A-7 Geotechnical Assessment of Pipeline Through the Watershed

A-8 GVWD Data on Trespassers, Turbidity and Construction

A-9 Letter from GVRD to PCEC

A-10a Energy Project Certificate Application and Environment/ Resources/Land Use Review

A-10b Report on Environmental, Resource and Land Use Considerations

A-10c Coquitlam Watershed Summary

A-10d Commission Decisions, Phases I and II

B-1 BCUC Staff Information Request

B-2 Information from contract documents: Mainland Contract — Construction Requirements

B-3 Pipe Sizing response and question

B-4a Commission Decision, Phases I and II (Routing)

B-4b Commission Decision, Phase III (Watershed)

B-5 Transcript p. 4426 — Reference to 12-inch diameter line

APPENDIX D-2

Information Supplied in Response to Inquiry Information Requests by Pacific Coast Energy Corporation

1. "Route Assessment — Coquitlam Lake Watershed" report by Stanley Associates Engineering Ltd., March/89.
2. PCEC submission to GVRD dated March 3/89.
3. Volume 2 of PCEC's Application detailing "Environmental Considerations" of Coquitlam route.
4. "Environmental Procedures Manual" — Volume 3 of PCEC's Application — detailing procedures that PCEC would follow in undertaking pipeline construction.
5. PCEC construction drawings:
   VI-PL-TM-101 — Typical settling pond
   VI-PL-TM-283A — Typical protective concrete pad for debris flows
   VI-PL-TM-283B(1) — Typical protective pad in bar ditch within avalanche area
   VI-PL-TM-283B(2) — Typical pipeline installation through catch basin
   VI-PL-TM-283C — Typical installation for pipeline in bar ditch areas
   VI-PL-TM-314 — Typical rock anchors
   VI-PL-TM-321 — Typical cross drain installation.
6. Activity Reports and Correspondence.
7. PCEC mosaics for the route through the Coquitlam watershed:
   VI-ML-001 — km 2.42 to km 7.0
   VI-ML-007 — km 7.0 to km 14.0
   VI-ML-014 — km 14.0 to km 21.0
   VI-ML-021 — km 21.0 to km 28.0.
8. 1:250,000 scale EMR topographic map No. 92G (Vancouver) detailing Coquitlam Lake, Indian Arm and Widgeon Creek routes.
9. Contractors' bids for construction of watershed section.
10. "Application/Engineering" — Volume 1 of PCEC's Application (dated November/88) detailing design and capacity of facilities, construction schedule and capital cost summaries.
11. Amendments to PCEC's Application (Volume 8 dated December/88).
12. "Geotechnical reconnaissance of route from Coquitlam Lake to Brandt Creek via Indian Arm" (Hardy BBT, Dec. 23/88).
13. Contour maps illustrating Indian Arm lower route volume take-offs (Hardy BBT, May 5/89). First page marked "KM 6.7 to 7.8."
14. Photos — Indian Arm (Hardy BBT, May 8/89).
15. Indian Arm (upper route) volume take-off (Hardy BBT report dated May 23/89).
16. Photos — Proposed Pipeline, Coquitlam Watershed Alignment.
17. "Preliminary Pipeline routes up Indian Arm — Location of WCE and GVRD Alternatives." Plates 1 to 6 (Hardy BBT Drawings).
18. PCEC capital cost estimates:
    B.C. Gas — Coquitlam Lake route to East Squamish
    B.C. Gas — Indian Arm route to East Squamish.
19. Lands and Land Rights — Cost Estimate (dated Oct. 30/87).
20. Clearing costs per hectare for Indian Arm and Coquitlam Lake routes.

21. External coating costs — Coquitlam Lake route.
22. Estimates of rock ditch and slashing quantities along Coquitlam Lake (Hardy BBT letter, February 17/89).
23. Documents for Vancouver Island Pipeline:
    a. Contract Documents — No. 89-003 (2 volumes) Mainland Contract
    b. Contract Documents — No. 89-004 (3 volumes) Island Contract
    c. Addenda A to J to the Contract Documents.
24. PCEC Capital Cost Estimate
    Addenda C and D to the Contract Documents.
25. Notes of Pre-bid meeting held March 27, 1989.
26. Memorandum to file from John Reimer dated 89/03/06.
29. Report to PCEC by Hardy BBT Limited dated May 30/89, "Revised Spreadsheets for Bolting & Laid-Back Costs for the Proposed Upper (GVRD) Alternate Route."
30. Hardy BBT Limited Report dated June 17, 1989, "Photographs of Activities in Coquitlam Watershed."
31. Hardy BBT Limited Report dated June 16, 1989, "Volume Estimate for Proposed Commission Route on East Side of Indian Arm."
32. Hardy BBT Limited Report dated June 16, 1989, "Volume Takeoff Sections for Proposed Commission Route on East Side of Indian Arm."
33. Maps on Preliminary Pipeline Routes up Indian Arm — Location of WCE and GVRD Alternatives, Plates 1–5.
34. Hardy BBT Limited Report dated June 20, 1989, Reconnaissance of West Side of Indian Arm.
35. Hardy BBT Limited Report dated February 2, 1989, "Geotechnical and Terrain Considerations for Proposed Natural Gas Pipeline Through Coquitlam Watershed."
36. Hardy BBT Limited Report dated July 11, 1989, "Revisions to Spreadsheet and Plates 1 to 6 for Commission Route on East Side of Indian Arm."
37. Pacific Coast Energy Corporation Contract Documents — No. 89-003A — 273.1 mm O.D. Vancouver Island Pipeline Mainland Contract, April 1989, Volume 1 of 2.
38. An application by Pacific Coast Energy Corporation for an Energy Project Certificate to construct and own pipeline facilities to provide natural gas transmssion service to and on Vancouver Island:

    Volume 1 — Application/Engineering, November, 1988

    Volume 7 — Feasibility Study of Malaspina Strait and Georgia Strait Gas Pipeline Crossings

    Volume 8 — Amendments dated December 1988.
39. Exhibit 21, Appendix B to Table 1, filed January, 1989 in the BCUC hearing of an application by PCEC for an EPC to construct a pipeline to Vancouver Island: World-wide summary of major bottom-pull submarine pipeline installations in sequence of installed length (11 pages).
40. Exhibit 33, filed January 26, 1989 in the above BCUC hearing: Summary of bottom-tow submarine pipeline installations (1 page).
41. Transcript, Volume 3, pages 477–480 (the above BCUC hearing): More detailed explanation by Mr. Timmermans of a recent bottom-pull in the Gulf of Mexico in 1987.

APPENDIX D-3

Information Supplied in Response to Inquiry Information Requests by Greater Vancouver Water District

1.	Letter Westcoast to GVRD	Oct. 1, 1984
2.	Letter GVRD to Westcoast	Oct. 30, 1984
3.	Letter Westcoast to GVRD	Mar. 21, 1988
4.	Letter GVRD to Westcoast	Apr. 27, 1988
5.	Letter Prov. of B.C. (Ministry of Health)	Nov. 25, 1988
6.	Letter GVRD to Ministry of Health	Dec. 19, 1988
7.	Letter Westcoast to GVRD	Jan. 10, 1989
8.	Letter Nathanson, Schachter & Thompson to B.C. Utilities Commission	Jan. 20, 1989
9.	Letter GVRD to Westcoast	Jan. 31, 1989
10.	Westcoast chronology of events with GVRD (Jan. 31 from transcript discussions — Exhibit 40 from Jan. 31, 1989)	
11.	Transmittal Westcoast to GVRD	Feb. 10, 1989
12.	Letter and enclosures Pacific Coast Energy Corp. to GVRD (and minutes of Feb. 7 meeting)	Feb. 15, 1989
13.	Transmittal (Hardy BBT Coquitlam Rock Quantities) to GVRD	Feb. 20, 1989
14.	Transmittal Westcoast to GVRD (Indian Arm–Coquitlam Lake Rock)	Mar. 2, 1989
15.	Letter Pacific Coast Energy Corp. to GVRD	Mar. 3, 1989
16.	GVRD Report (and enclosures) to Administration Board	Mar. 9, 1989
17.	Letter GVRD to Pacific Coast Energy Corp.	Mar. 15, 1989
18.	Letter Pacific Coast Energy Corp. to GVRD	Mar. 20, 1989
19.	GVRD Water and Waste Management Committee Report (incl. revised motion)	Mar. 22, 1989
20.	Letter GVRD to Pacific Coast Energy Corp. Letter GVRD to Energy, Mines and Petroleum Resources (B.C.) Letter GVRD to Energy, Mines & Resources (Fed.) Letter to GVRD to B.C. Utilities Commission	Apr. 4, 1989 Apr. 4, 1989 Apr. 4, 1989 Apr. 4, 1989
21.	Letter B.C. Ministry of Energy, Mines and Petroleum Resources to GVRD	Apr. 19, 1989
22.	Letter B.C. Ministry of Energy, Mines and Petroleum Resources to GRVD	Apr. 25, 1989
23.	Letter GVRD to Energy Mines and Petroleum Resources	Apr. 27, 1989
24.	GVRD chronology of events	May. 1, 1989
25.	GVRD Report to Water and Waste Mgmt. Committee	Apr. 26, 1989

26.	Recommendation — GVRD — Jack Davis Meeting	May 2, 1989
27.	Pacific Coast Energy Corp. Cost Figures Indian Arm vs. Coquitlam — received	May 10, 1989
28.	Thurber Consultants Geotechnical Report on Coquitlam Watershed (B.C. Utilities Commission Exhibit No. 66)	Feb. 16, 1989
29.	Economic and Engineering Services Water Quality Impact Assessment Report (B.C. Utilities Commission Exhibit No. 64)	Feb. 16, 1989
30.	Letter Ministry of Environment and Parks to B.C. Hydro and Power Authority	Mar. 3, 1989
31.	Agreement between B.C. Hydro and Power Authority and Greater Vancouver Water District	Nov. 20, 1989
32.	Chronology — Coquitlam Lake Water Supply (Including Agreements)	
33.	Agreement between Coquitlam Water Works Company Ltd. and Corporation of the City of New Westminster	Sept. 2, 1889
34.	Agreement between His Majesty the King and Vancouver Power Co. Ltd.	Mar. 24, 1910
35.	Agreement between His Majesty the King and Vancouver Power Co. Ltd.	Oct. 22, 1913
36.	Corporation of City of New Westminster By-Law No. 1268	
37.	Agreement between Corporation of the City of New Westminster and Greater Vancouver Water District	Jan. 1, 1931
38.	Water Rights Branch — Final Water Licence	Oct. 1, 1957
39.	Watershed Lease dated May 3, 1944	
40.	Watershed Lease dated Aug. 20, 1942	
41.	Watershed Lease dated Aug. 10, 1953	
42.	Water Quality Summary May 16, 1987 — Dec. 31, 1988	
43.	GVWD Operations Data including: • Plot of Flows • Population Served • Service Area • 5 Year Capital Expenditure Program Outline • 1989 Flow Projection • System Operation	
44.	Coquitlam Watershed Management Items as summarized in GVRD memo dated May 26, 1989 • Road Construction and Harvesting maps and data • Construction Activity Regulations • Personnel Level	
45.	Tabulation of dates of construction and cost of individual sections of the watershed main road and construction forces engaged (to supplement Item 44)	

46. Coquitlam Mainline Road Construction Summary
    - Total Untrended and Trended Cost
    - Concrete Bridge and Box Culvert Summary
    - Cross Sections of Major Stream Crossings
47. Three maps of Coquitlam Watershed
    - Dates of Construction
    - Size and Location of Culverts
    - Stream Courses Which Do Not Dry Up
48. Singleton & Associates Engineering Ltd. Pipeline Routing Report dated May 9, 1989
49. Thurber Consultants Ltd. Preliminary Geotechnical Assessment — Indian Arm Report dated May 14, 1989
50. Amending Indenture — March 7, 1967
51. Copy of Tender No. 183.84.10 for Yarding, Loading and Handling of Logs
52. Copy of Cutting Permit No. 3 (Coquitlam Watershed) Term Jan. 15, 1988 to Jan. 14, 1989 with Ministry of Forests and Lands
53. Copy of Tender No. 090.89.06 Road Grade Construction
54. Summary of the Aqua Terra Classification System
55. Dr. Doug Golding's Reports to the Water and Waste Management Committee July, 1988 and July 1, 1986
56. Cost Estimate of GVRD road construction up Indian Arm Alternative B Route
57. British Columbia Drinking Water Quality Standards — 1982
58. Greater Vancouver Water District Act (1924)
59. GVWD 1988 and 1987 Financial Statement Excerpts
    - Exhibit B — Balance Sheet
    - Exhibit E — Revenue and Expenditure
    - Schedule 6 — Watershed Management Program
60. Watershed Entry Permit Master List — Current total
61. GVWD Contingency Plan for Oil Spills within Watershed Lands
62. GVWD Coquitlam Watershed Entry Records 1987, 1988
63. Copy of letter from Gregory Kirmeyer to Robert Jones dated April 13, 1988, *Re:* Draft Report on Turbidity in Source Waters (30 pages)
64. Booklet entitled Guidelines for Canadian Drinking Water Quality, printed 1987 (20 pages)
65. Note to H. T. Heath *Re:* Coquitlam Shutdown Procedure, dated June 15, 1989 (2 pages)
66. Proposed Program for East-West Transfer of Water (2 pages)
67. Map of Coquitlam Watershed outlining the proposed 1989 harvesting area.

APPENDIX E

Report of Inquiry Senior Pipeline Advisor, Robert Sharman

Province of British Columbia

Douglas L. MacKay, P.Eng.
COMMISSIONER

Inquiry into Pipeline Routes
In and Around Coquitlam
Watershed

#902, 865 Hornby St.
Vancouver, B.C.
V6Z 2G3
Telephone: 660-6555
Facsimile: 660-7622

July 21, 1989

Mr. Douglas L. MacKay
Inquiry Commissioner
#902, 865 Hornby Street
Vancouver, British Columbia
V6Z 2G3

Dear Commissioner:

I was retained to assist in the Inquiry ordered by the Lieutenant-Governor in council on May 18, 1989. You asked that I provide services relative to the terms of the Order requiring your Inquiry to review the Coquitlam Watershed and alternative pipeline routes, to report on terms and conditions for construction and operation of the Pipeline in a safe, prudent and environmentally acceptable manner, and to recommend on construction practices, timetables, cost estimates, and pipeline reliability requirements.

To achieve this, by the terms of my contract signed and dated 23 May 1989, the following services were required:

i) to advise on all matters relating to pipeline routes, design, construction, costs, safety and reliability;

ii) to review information made available in the form of engineering reports, consultants' reports, maps, airphotos, transcripts of evidence and other means, relating to pipeline routing through the Coquitlam Watershed and alternatives;

iii) to report verbally, in written report(s) and through sworn testimony as an expert witness; and

iv) to assist in the direction of other technical consultants.

In fulfillment of these requirements, I reviewed the extensive information base which was supplied to the Inquiry by the B.C. Utilities Commission on May 24, 1989 and which continued to be made available throughout its work by the GVWD, PCEC and their consultants.

From this information, augmented by aerial reconnaissance, I identified six alternative routes. These are:

1 -- Kilgard to Squamish

2 -- Coquitlam Watershed

3 -- Indian Arm - East

4 -- Indian Arm - West

5 -- Seymour Watershed

6 -- Capilano Watershed

I reviewed these alternatives on the basis of cost, environmental impacts and water quality concerns. From this evaluation, I concluded:

Route 1 should not be considered further, because of cost and environmental impacts. Mr. Ken Farquharson aided in this evaluation of environmental impacts, outlining how it unnecessarily opens up a new pipeline corridor rather than using existing facilities and existing rights-of-way, how it crosses an area of significant value as wildlife habitat in the vicinity of Pitt Polder, and has areas of difficult mountain and marshland terrain in portions of the route.

Route 5 should not be considered further because:

(a) there is not a sufficient natural gas supply on the North Shore of Burrard Inlet to provide the necessary volumes and pressure of gas needed to serve Vancouver Island. It would be necessary to construct major new pipeline system improvements thereby adding significantly to both the cost and environmental impacts from new construction in developed areas;

(b) the alternative to this would be to extend the system from Coquitlam, with associated costs and environmental impacts;

(c) ground conditions at the north of the Seymour Watershed make pipeline construction expensive and difficult;

(d) this routing does nothing to resolve the water quality concerns, as it places a pipeline through a GVWD Watershed

Route 6 should not be considered further because of the reasons (a) (b) and (d) above. In addition, I am advised that ground conditions in the Capilano Valley would make the potential for turbidity in the water supply much greater than in either of the other GVWD watersheds.

My evaluation led me to conclude that none of these 3 routes would have any cost advantage over the Coquitlam Watershed or Indian Arm routes (Routes 2, 3 & 4). Therefore, I concentrated my efforts on these latter routes.

I have reported verbally and in various written forms throughout my work. In accordance with the consultative and non-adversarial approach with which you wished the Inquiry to be conducted, I have reported information and opinions not only to the Inquiry, its staff, counsel and consultants but also to the GVWD and PCEC. Much of my time was spent in this consultative process.

The findings of my work were reported by way of sworn evidence at the Inquiry's public hearing on 28 June 1989 and again on 20 July. At the first occasion, I provided an overview of the work being undertaken to review the routing alternatives. Then, on 24 July, the written cost-sheets and notes for all routes were placed on the public record. These are attached to my report and contain detailed quantities, unit prices, and costs for the routes via the Coquitlam Watershed (37.1 km), Indian Arm - East (26.2 km) and Indian Arm - West (24.0 km on land and 3.2 km dual marine crossings). The sheets also present the Inquiry Advisors' most probable estimates of the costs of the three routes, together with "High" and "Low" estimates individually developed for each route.

I conclude my report to you, Mr. Commissioner, by setting out the other technical consultants whom I have retained and/or directed in order to assist in fulfilling your Inquiry's terms of reference:

Mr. Keith Hunt, engineering technician, who reviewed earlier routings, inspected alternative routes on the ground and by helicopter, compiled cost calculations and quantity estimates, and assisted in the preparation and tabulation of the Inquiry's preliminary cost estimates.

Mr. Olav Naas, rock-work and excavation specialist, who inspected all routes by air and on the ground, reviewed documents, maps and consultants' reports, and advised on quantities and costs of right-of-way clearing, road-building, grading, tunneling and route safety.

Mr. Ken Farquharson P.Eng. MICE , environmental engineer, who reviewed all routes from the point of view of the environment, land and resource use and other values, and gave advice on potential environmental impacts and mitigation methods and costs. Mr. Farquharson was in turn assisted by Mr. Geoffrey Smith, a biologist who examined fisheries values in Indian Arm and the Indian River. Mr. Farquharson provided sworn testimony to the Inquiry's hearings on June 29 and supplied a written report included as an Appendix to this report.

Dillingham Construction Ltd., who investigated the underwater components of the Indian Arm - West route, including estimates of the costs, quantities, timing and preferred construction techniques. The company's brief report is filed with the Inquiry's Documents as Exhibit 25 - Tab 13.

McIlhaney Geosurveys Ltd., who advised on the feasibility of the underwater crossings on the Indian Arm - West route and carried out a limited bathymetric survey to determine if the crossings could be considered logistically feasible and to provide the basis for an estimate of their costs.

Mr. Milos Stepanek, MSc. P.Eng., who reviewed all routes by means of air and ground survey, mapping, photographs and videotape. He worked in accordance with detailed terms of reference and provided advice on the practicality, safety and integrity of the Indian Arm - West route, including the means of ensuring the safety of construction crews, householders and powerlines, and on the quantities of rock to be hauled during construction. He also reviewed, evaluated and rated all routes studied in detail against specific criteria and the project objectives. He reported in a written report and in sworn evidence at the Inquiry's public hearings on July 20, 1989.

Singleton Associated Engineering Ltd., were retained by the Inquiry to develop independent estimates of the quantities, unit prices and costs for all three routes following the conclusion of the consultations under the Inquiry's auspices aimed at securing estimates mutually-agreed between GVWD, PCEC and the Inquiry Advisors. (Singletons had earlier been retained by GVWD to assist them in route evaluations and

costing.) The company's reports were based on site visits, reviews of PCEC and GVWD documents, other consultant reports and mapping. Their resulting reports are found in the Inquiry's Documents as public hearing Exhibit 25 Tabs 9, 10, 11 and 12.

The Commonwealth Seager Group, consulting corrosion engineers, were retained as sub-consultants to Singleton Associated Engineering Ltd. The company provided a report on the hazards to the pipeline caused by proximity to the 500 kv Hydro powerline on the Indian Arm - East route along with their suggested means and costs of mitigating the hazards during construction and operation.

I appreciate the opportunity to have assisted you in your Inquiry and am grateful to you, the members of the Inquiry's staff and consulting team, and to all those associated with GVWD and PCEC for their cooperation and advice.

Yours very truly,

R.S. Sharman.

pp R.S. Sharman

COQUITLAM WATERSHED INQUIRY COST ESTIMATE
ROUTE A - 37.1 KM LAND PIPELINE
SOURCE: INQUIRY ADVISORS

DATE: 19-Jul-89
TIME: 10:15 AM

		Lineal Metres	--Inquiry Advisors-- LOW Cost/LM	Cost (000's)	--Inquiry Advisors-- Most Probable Costs Cost/LM	Cost (000's)	--Inquiry Advisors-- HIGH Cost/LM	Cost (000's)
1	Land and Rights			$191		$191		$191
2	Materials							
3	- Line Pipe			$3,331		$3,331		$3,331
4	- Coating - External			563		563		563
5	- Internal			262		262		262
6	- Other Material							
7	- Fabrication			90		90		90
8	- Miscellaneous			5		5		5
9								
10	Total Materials			$4,251		$4,251		$4,251
11	Installation							
12	- Clearing	23,400	34	$796	34	$796	34	$796
13	- Grade	37,100	63	2,337	70	2,597	77	2,857
14	- Ditch	37,100	48	1,781	53	1,966	59	2,189
15	- Pipeline	37,100	119	4,415	132	4,897	139	5,157
16								
17	Subtotal			$9,329		$10,256		$10,999
18								
19	Civil Works			$454		$454		$454
20	Tunnel (2.74m x 3.66m)			0		0		0
21	Tunnel (2.44m x 3.05m)			0		0		0
22	Access Roads			0		0		0
23	Submarine Pipelines			0		0		0
24	Horizontal Drilling			0		0		0
25	Rock Bolts			150		150		150
26	Aerial Crossings			0		0		0
27								
28	Total Installation			$9,933		$10,860		$11,603
29								
30	Radiography			$84		$84		$84
31	Start-up & Testing			67		67		67
32	Inspection			581		581		581
33	Compensation & Mitigation			704		904		904
34								
35	TOTAL DIRECT COSTS			15,811		16,938		$17,681
36								
37	Other Costs							
38	Engineering Overhead		2.50%	395	2.50%	423	2.50%	$442
39	Omission/Contingency		10.00%	1,621	10.00%	1,736	10.00%	1,812
40	A.F.U.D.C.		2.80%	499	2.80%	535	2.80%	558
41								
42	Total Other Costs			$2,515		$2,694		$2,812
43	Contractor's Profit (on line item 17)		12.00%	$1,119	15.00%	1,538	15.00%	1,650
44								
45	GRAND TOTAL			$19,445		$21,170		$22,143

Notes to Cost Estimate July 19, 1989

Inquiry Advisors Most Probable Costs

Route A - 37.1 km Land Pipeline

1. **Land & Rights** - $191.000

Part of costs developed in "Consultative Process for land Purchases and Legal Surveys Estimate as follows:

Private Land	$33,000.00
Crown Land	21,000.00
Legal Survey	137,000.00
Total	$191,000.00

3. **Line Pipe**

	linear	slack chainage
12"	24.0	25.2
10"	13.1	13.8
Total	37.1	39.0

Note: 24" pipe is included for purposes of this note in 10" pipe.

12" pipe: from Singleton Route A Table B.1 item 2
3,586,700 / 38,955 = 92.05 / km x 25.2 km = $2,320,000.00

10" pipe: from Singleton Route C Table B.1 item 2
1,846 / 252 = 73.25 x 13.8 km = $1,011,000.00

Total $3,331,000.00

4. **External**

12" yellowjacket	25.2 km x $10.70 =	$270,000.00
12" rockshield	10.5 km x $11.85 =	124,000.00
10" yellowjacket	13.8 km x $9.00 =	124,000.00
12" rockshield	4.5 m x $10.00 =	45,000.00
Total		$563,000.00

5. **Internal**

12"	25.2 km x $7.10 =	$179,000.00
10"	13.8 km x $6.00 =	83,000.00
Total		$262,000.00

Notes to Cost Estimate July 19, 1989

Inquiry Advisors Most Probable Costs

Route A - 37.1 km Land Pipeline

Page 2 of 4

7. Fabrication

Derived from estimates at Singleton Table B.1 Route A items 4(a) and 4(b).

8. Miscellaneous

Based on estimate of PCEC.

12. Clearing

The unit cost of $34.00 has been calculated as follows:

PCEC cost of $21.00/m x 16,400 m =	344,000.00
New construction @ $63.00/m x 7,000m =	441,000.00
	$785,000.00

$785,000.00 / 23,400 = $34.00 /m

13. Grade

Unit rate of $70.00 has been developed as follows:

Common Grade	16,400 m^3 @ $14 =	$230,000.00
Rock Work	54,000 m^3 @ $18 =	972,000.00
Haul Rock	54,000 m^3 @ $16 =	864,000.00
Haul Common	16,400 m^3 @ $16 =	262,000.00
Boulder	24,620 m^3 @ $18 =	284,000.00
		$2,607,000.00

2,607,000.00 / 37,100 = $70.00

14. Ditch

Unit rate is based on 50% rock and 50% common ditch, and is derived from PCEC prices as follows:

Common @	$19.98
Rock @	$85.54
Total	$105.30

105.50 / 2 = $53.00

Notes to Cost Estimate July 19, 1989

Inquiry Advisors Most Probable Costs

Route A - 37.1 km Land Pipeline

15. Pipeline

Majestic and PCEC estimates			$119.00
Special back fill:			
in rock	13,200 x 18 =	$238,000.00	
in tallus	500 x 54 =	27,000.00	
with foam	700 x 325 =	228,000.00	
Total		$492,000.00	
492,000.00 / 37.1 =			13.00
Total			$132.00

19. Civil Works

Made up of the following sums:

Foam	$96,000.00
Rivers & Creeks	80,000.00
Road Crossings	42,000.00
Swamp Weight	11,000.00
Concrete Slabs	60,000.00
Drain Pits, Cross Drains & Culverts	50,000.00
Sand Bags	113,000.00
Total	$454,000.00

25. Rock Bolts - $150,000.00

Lump sum estimate of rock bolting required (together with wire mesh) for crew protection in areas of existing an new rock faces.

Notes to Cost Estimate July 19, 1989

Inquiry Advisors Most Probable Costs

Route A - 37.1 km Land Pipeline

Page 4 of 4

30. Radiography - $84,000.00
Supplied by PCEC

31. Start-up and Testing - $67,000.00
Supplied by PCEC

32. Inspection - $581,000.00
Supplied by PCEC

33. Compensation & Mitigation - $904,000.00

Cost developed by K. Farquharson

Logging Stand Down	$350,000.00
GVWD Road Reconstruction	200,000.00
GVWD Road Resurfacing	304,000.00
Electrical Effect Mitigation	20,000.00
Dam Rehabilitation	30,000.00
Total	$904,000.00

COQUITLAM WATERSHED INQUIRY PRELIMINARY COST ESTIMATE
ROUTE B - 26.2 KM LAND PIPELINE
SOURCE: INQUIRY ADVISORS

DATE: 19-Jul-89
TIME: 09:45 AM

		Lineal Metres	--Inquiry Advisors-- LOW Cost/LM	Cost (000's)	--Inquiry Advisors-- Most Probable Costs Cost/LM	Cost (000's)	--Inquiry Advisors-- HIGH Cost/LM	Cost (000'
1	Land and Rights			$240		$240		$240
2	Materials							
3	- Line Pipe			$2,026		$2,026		$2,026
4	- Coating - External			350		679		679
5	- Internal			133		165		165
6	- Other Material							
7	- Fabrication			100		100		100
8	- Miscellaneous			131		131		131
9								
10	Total Materials			$2,740		$3,101		$3,101
11	Installation							
12	- Clearing	26,200	62	$1,624	66	$1,729	66	$1,729
13	- Grade	26,200	182	4,768	192	5,030	206	5,397
14	- Ditch	26,200	78	2,044	94	2,463	104	2,725
15	- Pipeline	26,200	193	5,057	204	5,345	214	5,607
16								
17	Subtotal			$13,493		$14,567		$15,458
18								
19	Civil Works			$1,071		$1,071		$1,071
20	Tunnel (2.74m x 3.66m)			0		0		0
21	Tunnel (2.44m x 3.05m)			0		0		0
22	Access Roads	3,340		815		862		908
23	Submarine Pipelines			0		0		0
24	Horizontal Drilling			500		600		1,000
25	Rock Bolts			500		500		2,879
26	Aerial Crossings			600		600		600
27								
28	Total Installation			$16,979		$18,200		$21,916
29								
30	Radiography			$79		$79		$79
31	Start-up & Testing			64		64		64
32	Inspection			379		379		379
33	Compensation & Mitigation			416		616		616
34								
35	TOTAL DIRECT COSTS			$20,897		22,679		$26,395
36								
37	Other Costs							
38	Engineering Overhead		2.50%	$522	2.50%	567	2.50%	$660
39	Omission/Contingency		10.00%	2,142	15.00%	3,487	15.00%	4,058
40	A.F.U.D.C.		2.80%	660	2.80%	749	2.80%	871
41								
42	Total Other Costs			$3,324		$4,803		$5,589
43	Contractor's Profit (on line item 17)		12.00%	1,619	15.00%	$2,185	15.00%	2,319
44								
45	GRAND TOTAL			$25,840		$29,667		$34,303

Notes to Cost Estimate July 19, 1989

Inquiry Advisors Most Probable Costs

Route B - 26.2 Km Land Pipeline

Lotus

3.	Line Pipe	Includes Table B.1 items 2(a) to 2(d) Note Singleton estimates include allowance for slack chainage.	$2,026,000.00
4.	Coating	External - includes Table B.1 items 3(a), 3(c) and 3(d)	$679,000.00
5.	Coating	Internal is same as Table B.1 3(b)	$165,000.00
7.	Fabrication	Includes Block Valves 4(a) Scrapers Traps c/w valves, concrete 4(b)	$60,000.00 $40,000.00
8.	Miscellaneous	Casing, weights, markers, test leads, 4(c)	131,000.00
12.	Clearing	Singleton Estimates plus additional allowance of 7 down days for possible weather factors: $62.00 + $4.00 = $66.00	
13.	Grade	Base Calculation Singleton Rock grade increase Weather factor - 7 days Control Blasting $192.00	$163.00/km 9.00 10.00 10.00
14.	Ditch	Base Calculation Adjust Rock and Common 50/50 Weather factor 7 days $ 94.00	$ 78.00 6.00 10.00
15.	Pipeline	Base Calculation Weather factor 7 days Foam pipe bedding Select backfill $204.00	$178.00 11.00 13.00 2.00

Note re foam: 1050m x $0.5m^3$ x $650

Notes to Cost Estimate July 19, 1989

Inquiry Advisors Most Probable Costs

Route B - 26.2 Km Land Pipeline

Page 2 of 2

19.	Civil Works	Singleton Estimate includes all items 5(e) to 5(q)		$1,071,000.00
22.	Access Roads	Shoo - Flies for	3.04 km	
		Access at 17 km	.30	
		Total	3.34 km	
		3.34 x $258.00 (line 12, 13 $258.00)		$815,000.00
24.	Horizontal Drilling - (sub-contract)			
25.	Rock Bolts - (sub-contract)			
26.	Aerial Crossing - (sub-contract)			
30.	Radiography - (sub-contract)			
31.	Start up & testing (by owner)			
32.	Inspection - (sub-contract)			
33.	Compensation & Mitigation			
	Costs developed by K. Farquharson			
		Aquatic (fish)	$ 50,000.00	
		Compensation to cottage owners	400,000.00	
		Buntzen Lake Recreation	30,000.00	
		Electrical Mitigation	136,000.00	
		Total		$616,000.00
39.	Omission & Contingency			
	Increased from 10% to 15% to reflect higher risk.			
40.	Contract Profit			
	Increased from 10% to 15% to reflect higher risk.			

COQUITLAM WATERSHED INQUIRY COST ESTIMATE
ROUTE C - 24.0 KM LAND, 3.2 KM DUAL MARINE CROSSING
SOURCE: INQUIRY ADVISORS

DATE: 19-Jul-89
TIME: 09:45 AM

		Lineal Metres	--Inquiry Advisors-- LOW Cost/LM	Cost (000's)	--Inquiry Advisors-- Most Probable Costs Cost/LM	Cost (000's)	--Inquiry Advisors-- HIGH Cost/LM	Cost (000's)
1	Land and Rights			$217		$217		$217
2	Materials							
3	- Line Pipe			$2,479		$2,479		$2,479
4	- Coating - External			802		802		802
5	- Internal			192		192		192
6	- Other Material							
7	- Fabrication			250		250		250
8	- Miscellaneous			5		5		5
9								
10	Total Materials			$3,728		$3,728		$3,728
11	Installation							
12	- Clearing	24,000	40	$960	44	$1,056	44	$1,056
13	- Grade	24,000	85	2,040	113	2,712	123	2,952
14	- Ditch	24,000	52	1,248	86	2,064	94	2,256
15	- Pipeline	24,000	135	3,240	146	3,504	152	3,648
16								
17	Subtotal			$7,488		$9,336		$9,912
18								
19	Civil Works							
20	Tunnel (2.74m x 3.66m)			$475		$475		$475
21	Tunnel (2.44m x 3.05m)			0		0		0
22	Access Roads	700		0		0		0
23	Submarine Pipelines	6,400		88		110		117
24	Horizontal Drilling			9,400		9,400		9,400
25	Rock Bolts			0		0		0
26	Aerial Crossings			280		280		280
27				0		0		0
28	Total Installation			$17,731		$19,601		$20,184
29								
30	Radiography			$69		$69		$69
31	Start-up & Testing			67		67		67
32	Inspection			476		476		476
33	Compensation & Mitigation			427		477		477
34								
35	TOTAL DIRECT COSTS			22,715		24,635		$25,218
36								
37	Other Costs							
38	Engineering Overhead		2.50%	568	2.50%	616	2.50%	$630
39	Omission/Contingency		10.00%	2,328	15.00%	3,788	15.00%	3,877
40	A.F.U.D.C.		2.80%	717	2.80%	813	2.80%	832
41								
42	Total Other Costs			$3,613		$5,217		$5,339
43	Contractor's Profit (on line item 17)		12.00%	$899	15.00%	$1,400	15.00%	1,487
44								
45	GRAND TOTAL			$27,227		$31,252		$32,044

Notes to Cost Estimate July 19, 1989

Inquiry Advisors Most Probable Costs

Route C - 24 km on Land + 2.3 Dual Marine Crossing

1. **Land & Rights** — $217,000.00

Land sum cost developed in Consultative Process
Estimate as follows:

Private Land	$80,000.00
Crown Land	
Legal Survey	137,000.00
Total	$217,000.00

3. Includes Singleton Report Table B.3 June 19, 1989 items 2(a) to 2(d).
Note: Singleton estimates include allowance for slack chainage.

4. Includes Singleton Report Table B.3 June 19, 1989 items 3(a), 3(c) and 3(d).

5. Includes Singleton Report Table B.3 June 19, 1989 items B.3 3(b).

7. Includes Scraper traps and valves as per Singleton Report Table B.3 June 19, 1989 item 4(a).

8. Includes test leads as per Singleton Report Table B.3 June 19, 1989 item 4(b).

12. Clearing $44 per metre

Clearing has been separated into three categories of difficulty:

a)	Sidesalope & Heavy	0.6 km - 3%	
b)	Easy	6.8 km - 28%	
c)	Regular	16.6 km - 69%	
	Total	24.0 km - 100%	
a)	Singleton + 20% =	$42 + $8 = $50 x 3% =	$4.50
b)	Route A Costs =	$24 x 28% =	6.50
c)	Singleton Costs =	$42 x 69% =	29.00
d)	Weather factor		4.00
	Total		$44.00

Notes to Cost Estimate July 19, 1989

Inquiry Advisors Most Probable Costs

Route C - 24 km on Land + 2.3 Dual Marine Crossing

Page 2 of 3

13. Grade - $107 per metre

Cost developed by Majestic is $99.00; this is the same as:

Singleton Rate (Table C)	$99.00
Weather factor	6.00
Control blasting	8.00
Total	$113.00

14. Ditch - $86 per metre

Unit rate is based on 50% rock and 50% common ditch unit rate developed by Singleton for same ratio of rock and common, with a factor of $10.00/m for weather factor.

15. Pipeline - $146 per metre

Unit rate for Route A		$119.00
Plus 2 crew moves:	$200,000.00	8.00
Weather factor		11.00
Foam pipe bedding		6.00
Select backfill		2.00
Total		$146.00

Note re foam: 400 m x 0.5 m^3 x $650 / 24,000 = $6/m

19. Civil Work - Lump sums $475,000

Made up of items 5(c) through 5(j) of Singleton's Table B.3 June 19, 1989.

22. Access road to centre of land portion; west side .7 km.

23. Marine Crossing - Lump sum $9,400,000.00

This is based on quote from Intech less material and contingency.

25. Rock Bolts

permanent: 1,100 in x $225/m =	$247,000.00
Dowels and miscellaneous	33,000.00
Total	$280,000.00

Notes to Cost Estimate July 19, 1989

Inquiry Advisors Most Probable Costs

Route C - 24 km on Land + 2.3 Dual Marine Crossing

Page 3 of 3

30. Radiography - $69,000.00
Supplied by PCEC

31. Start-up & Testing - $67,000.00
Supplied by PCEC

32. Inspection - $476,000.00
Supplied by PCEC

33. Compensation & Mitigation - $477,000.00

Cost Developed by K. Farquharson

i)	Aquatic	$250,000.00
ii)	Cottages	100,000.00
iii)	Buntzen Lake Park	30,000.00
iv)	Electrification Mitigation	97,000.00
	Total	$477,000.00

39. Omission & contingency

Increased to 15% to reflect higher risk.

43. Contractor's Profit

Increased to 15% to reflect higher risk.

APPENDIX F

Report of Inquiry Environmental Advisor, Ken G. Farquharson, P.Eng.

ASSESSMENT OF ALTERNATE ROUTES
FOR VANCOUVER ISLAND GAS PIPELINE
IN VICINITY OF COQUITLAM LAKE

REPORT OF K. G. FARQUHARSON, P.Eng. MICE

Introduction

This report is prepared to assist D. MacKay, P.Eng., appointed as sole Commissioner, to enquire into pipeline routes in and around Coquitlam Watershed in accordance with the terms of my contract with the Inquiry. It is not a comprehensive environmental review, but is intended to identify those aspects of the routes with environmental or socio-economic interest which may affect the choice of route. Testimony at the Inquiry's hearings on June 29 provided further information on the route assessment undertaken.

The routes reviewed are the Kilgard-Squamish bypass of the whole Coquitlam watershed by way of Pitt Lake, the route through the Coquitlam watershed (A) proposed by PCEC, a route along the east ride of Indian Arm (B), and a route along the west side of Indian Arm (C). The route along the east side of Indian Arm was originally identified by GVWD staff and refined to the point of consensus by Inquiry and PCEC staff. The route along the west side was identified by Commission staff with the assistance of GVWD staff.

Kilgard-Squamish Bypass

This route has the attraction that it avoids both the Coquitlam watershed and the difficult terrain of Indian Arm. However, it is a route with distinct environmental difficulties of its own due to its length (132 km) and location. The other alternatives vary from 52.5 to 63 km long. The route received only cursory attention because of its cost, over $70 million as

compared to up to or more than $40 million for alternatives, the duplication of the existing gas transmission system in the Fraser Valley, and because of environmental concerns.

The environmental concerns are many; a summary follows. Use of the route would require construction from 11 km through farmland, much of it with a high water table. It would require use of 224 ha of productive forest land in a region where timber supply is already tight. For 7 km west of Grave Falls it would require clearing of forest adjacent to the 500 kv right of way on exposed slopes high above the Fraser Valley. This would make a scar highly visible through much of the lower Fraser Valley.

Studies by B.C. Gas Inc.show that significant difficulties are posed to construction by having to accommodate the life-cycles of the various species of fish using the rivers crossed, and the timing of construction in Pitt Polder must be addressed in relation to use of the area by waterfowl. Pitt Polder is of regional importance for rearing and staying of waterfowl. Construction in the western part of Pitt Polder is usually limited to a limited period in August. Protection of the wetland vegetation is important and is difficult to achieve when excavating below the high water table.

From Pitt Polder to Squamish the route uses the valleys of Widgeon, DeBeck and Boise Creeks to reach the Mamquam Valley, and lies almost entirely in forested land. A 30 km length of this is through wilderness with no access developed to date.

As all these concerns over a length of 132 km can be eliminated by use of the existing gas transmission system in the Fraser Valley and construction of only 63 km of new line, the Kilgard-Squamish is not recommended from an environmental and land use perspective.

Route A - Coquitlam Watershed

Conditions along the route are shown in the following table.

km	0	-	2.5	Westwood Plateau, developable land
	2.5	-	5.0	Adjacent 500 kv right-of-way
	5.0	-	30.0	GVWD Watershed Area
	30.0	-	36.0	Crown Forest Land

The issues which have been identified are:

1. Westwood Plateau has been sold for residential development. The location of the compressor station relative to the residential development is important. Possible sites are adjacent to B.C. Hydro's Meridian substation at km 2 or at km 5. The new owners of the site will wish to limit restriction to their subdivision and road layout.

2. In the GVWD Watershed the sole significant environmental issue is the protection of water quality. Possible risks are turbidity due to construction activities and potential fuel spills during construction.

3. The forest lands of the GVWD are managed on a sustained yield basis and contribute to the local economy. Because of the location of the pipeline in the bar ditch the loss of productive forest land is estimated to be only 13 ha assuming a 20 m cleared right of way up to Coquitlam Dam and an additional clearing of 3 m width for the rest of the route.

In discussion of use of this route the important question is whether pipeline construction could occur in the watershed without increasing the present level of risk to water quality due to turbidity or fuel spills.

The GVWD have already accepted a certain level of risk by permitting some 40 men, logging trucks and construction machinery to work in the watershed. If the logging and road construction crews and their equipment were removed and a similar number of men and pipeline equipment were to operate in the watershed, it is my opinion that the level of risk would be virtually identical.

In the long term the erosion contributed by pipeline construction in the watershed will be much less than that contributed by the logging roads as the surface area open to active erosion is much less (Area of logging road surface is 93.5 km x 6 m =56.1 ha; area of disturbed portion of pipeline right of way excluding road areas used for piling excavated material, which would be open for erosion in any case, is 27 km x 3 m = 7.1 ha, assuming an average extra disturbed width of 3 m and assuming no revegetation of disturbed slopes).

The greatest threat to water quality comes from erosion during construction and in the first year after construction.

If construction were to occur in the Coquitlam Watershed it should be done during the period of driest weather, namely July through September.

There are various ways to reduce the risk of siltation which could be adopted. These are:

1. Cessation of logging during pipeline construction to reduce delay to pipeline construction as a result of having to accommodate logging traffic, and to prevent increasing level

of risk due to increased activity in watershed. Compensation might be necessary to achieve this if loggers cannot work elsewhere in GVWD lands.

2. Preconstruction of all river and stream crossings to ensure they are done in dry weather.

3. Provision of an adequate allowance for standby payments to the contractor to allow him to stop work during any rainstorms and the subsequent period of runoff.

4. Preconstruction of future planned logging road up Flyin Creek valley to GVWD boundary to provide a better designed and constructed base for pipeline construction than a tote road on the alignment defined for the road as proposed by PCEC.

5. Where large quantities of rock are to be removed to accommodate pipeline construction, blasting and removal should precede pipeline construction to ensure that pipeline construction is not delayed. It would reduce the level of risk of siltation if this slashing were to occur the year preceding pipeline construction.

Because of the restrictions placed on use of the watershed, many of the common conflicts on land use, such as with recreation or visual impact, are not a factor in this assessment. Also the location of the pipeline adjacent to the road results in minimal loss of wildlife habitat.

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